

Carolina Espinoza Sanhueza

Architect, Mg, PhD in Architecture

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Education

Ph.D. in Architecture. Laval University Quebec, Canada. 2024

Thesis title *Biophilic light and colour in interior architecture: Fostering occupants' well-being in northern regions*

Thesis advisor: Dr. Claude Demers (Architecture). Co-advisors: Dr. Marc Hébert (Photobiology), Dr. Jean-François Lalonde (Electrical Engineering)

WELL AP

Current

International WELL Building Institute IWPI

Enrolled (3-months study program)

Master in Sustainable Habitat and Energy Efficiency. Universidad del Bío-Bío, 2018

Concepción, Chile. Master thesis title: *Assessment of wooden lighting environments in educational buildings*.

Thesis advisors: Dr. Beatriz Piderit (Architecture). Co-advisor: Dr. Pierre Blanchet (Wood Science, Laval University)

Publications

1. **Espinoza-Sanhueza, C**, Hébert M, Lalonde JF, and Demers CMH. Towards an image assessment method to characterize light and color in architecture. *Intelligent Buildings International* 2025;0:0 1-17
2. **Espinoza-Sanhueza, C**, Hébert M, Lalonde JF, and Demers CMH. Evaluating Spatial Attributes of Surface Colors Under Daylight and Electrical Lighting in Sustainable Architecture. *Sustainability* 2025;17:4: 1653
3. Lalonde P, Hébert M, Lalonde JF, **Espinoza-Sanhueza C**, Demers CM. Imagery dataset of interior and exterior northern architectural spaces for photobiological lighting analyses. *Data in Brief*. 2024;55:110658
4. **Espinoza-Sanhueza C**. Hébert M, Lalonde JF, Demers CM. Dataset of images for visual and non-visual analyses of light and colour applications in architecture. *Data in Brief*. 2024;55:110755.
5. **Espinoza-Sanhueza C**, Hébert M, Lalonde JF, Demers CM. Biophilic analogous patterns for light responsive architecture during polar night: examining the photobiological effects of electrical lighting and surface colour configuration. *Building and Environment*. 2024;249:111125.
6. **Espinoza-Sanhueza C**, Hébert M, Lalonde JF, Demers CM. Exploring light and colour patterns for remote biophilic northern architecture. *Indoor and Built Environment*. 2023;0(0):1–18.
7. **Espinoza Sanhueza C**, Piderit M, Blanchet P, et al. Impacto en el confort visual y bienestar: integración de revestimientos en madera. *AUS* 2020; 66–79.
8. Piderit B, Cáceres C, **Espinoza Sanhueza C**. Daylight in the museum: Luminance distribution study using hdr photographs. In: *Sustainable Urban Communities towards a Nearly Zero Impact Built Environment*. Vitoria, Brazil, 2015.
9. Tapia Maureira CM, **Espinoza Sanhueza C**, Fuentes González H. Evaluación de Estrategias de Iluminación y Ventilación Natural en etapas tempranas del proceso de diseño de un Edificio de Oficinas en Talca, Chile. In: *5° Congreso Sudamericano de Simulación de Edificios / 27-28 Septiembre 2018 / Valparaíso (Chile)*. Valparaíso, Chile, 2018.

Scientific communications

1. **Espinoza-Sanhueza C.** Light, Colour and Wellbeing in Far North Lands. Oral presentation at: Transforming Birth Spaces, A Global Colloquium; 2025 Oct; Toronto, Canada. (Invited Speaker)
2. **Espinoza-Sanhueza C.** Impact de l'éclairage électrique et de la couleur pour un développement architectural durable et biophilique dans les régions du Nord. Oral Presentation presented at: 27e Colloque étudiant pluridisciplinaire du CRAD; 2023 Sep; Quebec City, Canada.
3. **Espinoza-Sanhueza C.** Biophilic light and colour in northern architecture Main findings and proposed assessment methods. Oral Presentation presented at: Réunion Scientifique Sentinelle Nord 2023; 2023; Quebec City, Canada.
4. **Espinoza-Sanhueza C,** Demers CM, Lalonde JF, Hébert M. Light-responsive coloured ambiance transition for biophilic architecture in northern regions. Oral Presentation presented at: PLEA 2022, Will Cities Survive?; 2022 Nov; Santiago, Chile.
5. **Espinoza Sanhueza C,** Demers CM, Lalonde JF, Hébert M. Development of an Image-Based Design Support Tool for Light and Colour in Biophilic Northern Architecture. Oral Presentation presented at: RSSN 2022; 2022 Oct; Quebec City, Canada.
6. **Espinoza-Sanhueza C,** Demers CM, Lalonde JF, Hébert M. Architectural colour combination effects for biophilic light-responsive ambiances under northern daylight. Blitz presented at: 4th Sentinel North Annual Meeting; 2021; Quebec City, Canada.
7. **Espinoza-Sanhueza C,** Demers CM, Lalonde JF, Hébert M. Potential of colour in interiors for human light-responsive ambiances in Northern locations. Oral Virtual Presentation presented at: 14th AIC Congress; 2021; Milan, Italy.
8. **Espinoza-Sanhueza C,** Demers CM, Lalonde JF, Hébert M. Colour transition analysis for biophilic lighting ambiances in northern buildings. Poster presented at: ASM 2021 ArcticNet; 2021; Ottawa, ON, Canada.
9. **Espinoza-Sanhueza C,** Demers CM, Lalonde JF, Hébert M. Couleur et bien-être sous la lumière naturelle du Nord : Exploration des effets apportés par la combinaison des surfaces en bleu et d'autres teinte [Internet]. Oral Presentation presented at: 89e Congrès de l'ACFAS; 2022; Québec, QC, Canada. Available from: <https://www.acfas.ca/evenements/congres/89/contribution/couleurbien-etre-lumiere-naturelle-du-nord-exploration-effets>
10. **Espinoza-Sanhueza C,** Demers CM, Hébert M, Lalonde JF, Potvin A. Coloured lighting ambiances in Nordic Architecture: simulating design strategies for healthy interior scenarios. Oral Virtual Presentation presented at: 26th Conference IAPS International Association People-Environment Studies; 2020; Québec, QC, Canada.
11. **Espinoza-Sanhueza C,** Demers CM, Hébert M, Lalonde JF, Potvin A. Intégration de stratégies d'éclairage artificiel pour des environnements intérieurs sains sous les latitudes nordiques. Poster presented at: 25e Colloque Interdisciplinaire Étudiants CRAD; 2020; Québec, QC, Canada.
12. **Espinoza-Sanhueza C,** Demers CM, Lalonde JF, Hébert M. Color quantity and position in indoor environments for visual comfort and effective circadian spaces in Northern territories. E-Poster presented at: ArcticChange 2020; 2020; Quebec City, Canada.
13. **Espinoza-Sanhueza C,** Demers CMH, Hébert M, Lalonde J François, Potvin A. Colour , Materialities and Lighting Photobiological and Biophilic Interior Design in Nordic Architecture. Poster Presentation presented at: 3rd Sentinel North Annual Meeting; 2019; Québec, QC, Canada.

Press Communications

- Echantillon de la recherche 2023. 2023 [cited 2023 Nov 11]. Lumière et couleurs : une architecture adaptée pour les villages nordiques. Available from: <https://salledepresse.ulaval.ca/2023/10/11/lumiere-et-couleurs-une-architecture-adaptee-pour-lesvillages-nordiques> 2023

- Rattrapage du vendredi 13 octobre 2023 [Internet]. Boréale 138. Côte-Nord; Available from: <https://ici.radio-canada.ca/ohdio/premiere/emissions/boreale-138/episodes/751724/rattrapage-vendredi-13-octobre-2023> 2023
- ICI Côte-Nord. Adapter l'architecture d'intérieur au milieu nordique avec la lumière et les couleurs. Available from: <https://ici.radiocanada.ca/nouvelle/2018060/besoins-lumiere-naturelle-biophilie-nord-architecture> 2023

Research experience

Postdoctoral Research Fellow

**Department of Architectural Science Toronto Metropolitan University.
Toronto, Canada**

**May 2025 –
Present**

Dedicated to investigate how envelope and window retrofit can prevent smoke exposure in indoors housing during wildfires in Northern Canada.

The data is being gathered using air quality sensors installed in Pelican Narrows and inside the houses.

- a) Building materials research.
Bulletproof window resistant and high-performance sealant to improve airtightness. Contact with contractors. Coordination and administration
- b) Data analysis.
The data analysis is being conducted using *python* libraries and *pandas* to evaluate the concentrations over time and evaluate the performance of the solutions.

Postdoctoral Researcher

**GRAP School of Architecture. Laval University. Sentinel North Project.
Quebec, Canada**

**May 2024 – April
2025**

Exploration of 360° captures to analyze the impact of light and colour in spatial diversity.

- a) Visits in two historical buildings in Quebec City with a diversity of luminous patterns.
National Assembly of Quebec and Vieux Seminaire of Quebec.
- b) Capture and data gathering using 360° high-dynamic range imagery
- c) Development of coding to merge and photo calibrate the images to emulate what the human eye perceives
- d) Manuscript in preparation to be submitted to a Elsevier scientific journal.

Research Assistant

Schola (Part time 10h/week)

2021

Research Assistant during the Summer Season at Schola (Expertise Platform for Schools in Quebec City)

- a) Research on lighting quality for learning spaces
Literature review of colour effects in learning spaces.
Building retrofit to improve daylight quality in primary and secondary schools.
- b) Presentation for the Ministry of Education Colloquium
Day 1: Lighting and colour presence in learning spaces.
Day 2: How do we improve existing secondary schools through building retrofit?

Research Intern

Chaire de Recherche du Canada en Bâtiments Durables (CIRCERB)

**January – June
2018**

Internship conducted to pursuit a master's degree thesis. Collaboration between Universidad el Bío Bío in Chile and Laval University in Quebec, Canada. Funded through ELAP Scholarship (Emerging Leaders of America Program) for Latin and Caribbean graduate students.

- a) Analysis of restorative effects of wood in learning spaces.
Literature review of the impact of wood coating in public spaces.
Analysis of wood applications in Canada.
Field visits.
- b) Assessment of occupant's perception in learning spaces (classrooms and gymnasiums)
Construction of reduced-scale models
Administered surveys
Data analysis.
- c) Thesis and published paper in Chile.

Teaching Experience

Lecturer, School of Architecture, Laval University. ARC-1032 Représentation architecturale avancée et pensée graphique. Winter 2025

This course developed the digital foundations of advanced architectural representation through computer-aided drawing and 3D modeling. It introduces graphic thinking, architectural drafting standards, and the use of computer-aided design and digital modeling in architecture. The course also explores computer-assisted representation techniques applied at the scale of the whole building, including dimensional surveying as well as basic concepts of compartmentalization and egress in building regulations.

- Tools implemented: SketchUp, AutoCAD, Illustrator, InDesign

Invited professor in graduate course Daylight and Lighting Design. Department of Design and Theory of Architecture. Universidad del Bío-Bío. Concepción, Chile. Spring 2024

This course explored principles and strategies of natural lighting in interior architecture, emphasizing both theoretical foundations and practical applications using simulation tools. Students have studied the role of daylighting promoting visual comfort, circadian entrainment and energy performance; analyses of study cases, and utilization of evaluation tools.

- Tools implemented: Velux, Climate Studio, AutoCAD, RADIANCE

Lecturer, School of Architecture, Laval University. ARC-1031 Fondements de la représentation architecturale. Fall 2024

This course focused on applying non-digital foundations of representation and communication in architecture through drawing and model-making. It introduces the uses of drawing in architectural practice, including principles of descriptive geometry, orthographic, oblique, and perspective projections, as well as technical drafting. Model-making is used to support the introduction and applied learning of these methods. The course also covers basic building regulations and architectural surveying, applied at the scale of simple building components.

- Tools implemented: Drawing, Technical drawing, AutoCAD, Illustrator

Lecturer, School of Architecture, Laval University. ARC-7021 Pensée constructive et architecturale du projet complet. Fall 2024

The course is structured around three complementary components of the “complete project” to which it is closely connected: a theoretical component, exploring the relationships between ideas, materiality, and technology in architectural design; an analytical component, focusing on the schematization of intentions and solutions related to site, program, and building systems; an applied component, where students produce technical drawings comparable to those used in professional practice.

Awards

- CRAD 2023 Outreach Grant. \$200 CAD 2023
- CRSC Students Awards 2023 - Colour Research Society of Canada. \$350 CAD 2023

- End of studies scholarship. Laval University. 5,000\$ CAD 2023
- Tuition Fee Waiver Scholarship at Laval University 2019 – 21
- Sentinel North Grant. 78,000\$ CAD for 4 years. 2019-23
- ELAP Scholarship. 10,000\$ CAD 2017
- Universidad del Bío Bío Award – Tuition Fee Waiver for graduate studies 2016
- Accelerated Passage Scholarship Universidad del Bío-Bío. Tuition Fee Waiver for graduate studies 2016
- PIE Scholarship Universidad del Bío-Bío. 15,000\$ USD 2015

Mentoring

- Teaching collaborator – Final year project 2025
- Project to become architecture in Professional Master Program, Laval University
- Nikita Baker – Arboréa : Aborder différemment les dernières étapes de la vie
 - Emmy Boissonneault - Nuniappoq [cueillir] : Le logement comme vecteur d'autonomie alimentaire au Nunavik
 - Noémie Thompson – Tuurngait : Interstices séquentiels comme élément spirituel de tissage architectural ravivant la chasse au Nunavik
 - Marie-Noëlle Tremblay – Gymnase nordique

Professional Development

- External consultant building lighting and thermal analyst. 2024
Residential project for LabNCo – Les Outardes
- Teaching Assistant, School of Architecture, Universidad del Bío Bío, Chile. 2016
Construction II (third year), Design Studio V (third year).
- Intern in Architecture – CICLO Arquitectura 2016
- Intern in architecture – RMR architect 2015

Peer Review

- Architecture 2025
MDPI
- Journal of Architectural Engineering 2025
Elsevier
- Scientific Reports. 2024
Nature
- Color Research and Application. 2023
Wiley and Sons.

Community Service

- Invited to collaborate in the construction of the “Ofrenda de Muertos” at the Cultural Institute of Mexico in Montreal, Canada Oct 2025
- Invited lecturer at the course Certifications and Innovations, Interior Design program, College LaSalle, Montreal, Canada. Sep 2025
- Invited panelist in “Towards the Professionalization of Interdisciplinary and Transdisciplinary Researchers for Sustainable Futures” discussion at the discussion Sentinel North Meeting 2025. Quebec City, Canada. May 2025
- Session Chair, Climate Imperative and Historic Building and Places. The Association for Preservation Technology International (APT) 2024
- Organizational committee 26^e colloque étudiante du Centre de recherche en aménagement et développement - CRAD, Université Laval 2021-2022

- Trésorière. Association Étudiante Sentinelle Nord AÉSN 2020-2021

Memberships

- Colour Research Society of Canada. Board Member. Canada. 2024 – 2025
- Study member Environment, Colour and Design (ECD). AIC. 2022 – current
- Centre de recherche en aménagement et développement CRAD. Laval University. 2019 – 2025
Quebec, Canada.
- Institut en environnement, développement et société (EDS). Laval University. 2019 – 2025
Quebec, Canada.

Software and Tools

Rhino 3D, Revit, Climate Studio, Velux, Design Builder, Python libraries (opencv, pandas, matplotlib, seaborn), AutoCAD, Suite Adobe, Microsoft 360°

Languages

Spanish (native), English (fluent – oral and writing) and French (fluent – oral and writing)

Professional References

Claude Demers, PhD Thesis supervisor.

Full Professor, School of Architecture, Laval University

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Québec, QC G1R 3V6

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Dr. Helen Stopps, PhD, PEng. Postdoctoral supervisor.

Assistant Professor, Department of Architectural Science. Toronto Metropolitan University

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Toronto ON M5B 1G6

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Dr. Marc Hébert. PhD Thesis Co-Supervisor

Full Professor, CERVO Brain Research Centre, Laval University

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Québec, QC G1E 1T2

Contact: marc.hebert@fmed.ulaval.ca