CENTER FOR INTERNATIONAL PROGRAMS | .VĒRITAS UNIVERSIDAD

BIO DESIGN

LEARNING STRATEGIES FOR DECARBONIZATION

Innovation inspired by nature: The Undergrowth.

Course Code BIODES-3000
Credits: 6
Term: J Term - January & Summer

Location
San Jose Campus and Rural Stations

Instructors

- Arch. Michael Smith, MSc. Sustainable Environmental Design.
- Tomás de Camino Beck, Ph.D.
- Arch. Rolando Madrigal, March.
- Rebeca Mora, MSc. Biology, Ph.D. Candidate in Science
- Mariano Barrantes, MSc. Tropical Biology and Natural Resource Mgmt.

Objective

The student will learn from and then emulating natural forms, processes, and ecosystems to create sustainable designs upon a decarbonization challenge seeking design strategies on the forest Undergrowth species as mentors.

Agenda

"At this point in our global ecological crisis, the survival of humanity will require a fundamental shift in our attitude toward nature: from finding out how we can dominate and manipulate nature to how we can learn from her. Biomimicry is a transdisciplinary/multidisciplinary discipline that requires the interaction of professionals of different formations at the design table." Janine Benyus

A Living Lab for innovation

Costa Rica contains 5% of the world's biodiversity in a territory is merely 0.03% of the earth's surface. It is considered a place with more diversity than many other areas in the world, explained by the geography of the country: located between two big continental masses and two oceans and with several mountain ranges. Also, the conservation policies developed during the 1970s have contributed to this invaluable treasure. Nowadays Costa Rica has adopted a leading plan to achieve a zero net emissions economy by 2050, in line with the objectives of the Paris Climate Change Agreement. It is a great challenge that requires true innovation that should come from a 3.8 billion years experienced laboratory called 'Nature'.

In that sense, biomimicry is a way of seeking sustainable solutions by borrowing life's blueprints, morphogenetic processes, and ecosystem strategies. At its most transformative, it brings us into right relations with the rest of the natural world, as students learning to be a welcome species on this planet.

Furthermore, the workshop aims to understand a design biological paradigm from a multidisciplinary approach; from which we have carefully selected the forest's Undergrowth to seek for species as mentors to develop design strategies that could enhance strategies for decarbonization plan challenge.

Goals

1. The student will understand the difference between learning about nature and learning from nature, using organisms as mentors.
2. The student will begin to understand how to use biomimicry design principles where disciplinary boundaries meet.
3. The student will develop a process for sustainable design solutions based on life genius.
4. The student will apply analogical and digital tools to develop the experimental design process.

Content

1. BASIC CONCEPTS OF BIOMIMETICS
    a. Origins of biomimicry, history.

   b. Biomimicry and other similar research lines.
   c. Ethos and definition of biomimetics
   d. Essential elements and basic concepts of Biomimicry
2. PRINCIPLES OF LIFE
   a. Principles of life, morphogenesis and examples:
      i. Function: form, processes and ecosystems.
      ii. Evolve to survive
      iii. Adapt to changing conditions
      iv. Integrate development with growth
      v. Use local materials-energy
   b. Use of the Principles of Life as a tool
3. METHODOLOGICAL PHASES: Phases of biomimetic design thinking and practices for its implementation.
   a. Identify
   b. Discover
   c. Create
   d. Evaluate
4. APPLIED TECHNOLOGY AND INNOVATION
   a. Tangible use of computer sciences and digital fabrication
   b. Prototyping
5. COMMUNICATION AND EXPRESSION
   a. Visual construction and characterization
   b. Diagraming data
   c. Diagraming phylogenetic process
   d. Editorial design, layout design, bi-media elements
   e. Applied production
6. DESIGN IMPLEMENTATION: Given a design challenge, each team will have to propose a product (inspired by nature) that solves the problem raised using the biomimetic methodology. A final presentation is evaluated that includes the prototype of the design, recognitions for the organisms/mentors, systems, emulated principles, integration of the principles of life and the detailed steps of the whole process. The development of visually appealing, clear and concise presentations will be encouraged.

Methodology

The course consists of master classes, demonstrative and theoretical-practical of different subjects. Within the didactic principles, the principle of proximity will be implemented, where the aim is to integrate teaching as close as possible to the student's daily life. The course covers the fundamental tools of biomimicry through lectures, exercises, conversations and reflections. It is a 3-week learning by practice experience. Through work with specific tools in nature, participants will develop relationships with the other members of the course and the environment in which they are learning. Starting with an induction on biomimicry specialized lectures series. Then a workshop-field trip to visit a National Park or Natural Reserve in order to illustrate the theoretical concepts presented in class and thus expand knowledge. Seeking for organisms as mentors to understand form, processes, and ecosystems in the undergrowth. The participants will be more intimately acquainted with the diversity of local species by spending time outdoors with the instructors and the rest of the participants fostering an atmosphere of dialogue and exchange. After the field sessions, back on campus a design process will be developed with a series of workshop sessions from which selected nature’s active design principles are explored by underpinning design, biology, and technology to develop sustainable design strategies and solutions upon the decarbonization challenge.The course ends with a final presentation to its colleagues, highlighting the integration of the learning program in a set of individualized instruments for its practice, strengthening and formalizing the relationship of the participant with their professional area through group feedback, exercises, conversations and reflection. The main methodological phases are:

- **Theoretical Induction:** Lecture series will introduce specialized topics such as:
  - Biomimicry Ethos and Design Challenge.
  - Principles of Life
  - Innovation Inspired by Nature.

  - Discovering Mentors in Nature.
  - Functions in nature; evolution and relations.
  - Form, Process and Ecosystems.
  - The Undergrowth.
  - Methodology: Identify, Discover, Create, Evaluate, Implement.
  - The power of the limits and nature's laws.
  - Technological Enablers and prototyping.
- **Identify:** Field trip at the rainforest. Seeking for an organism in the undergrowth as mentors. A series of on-site workshops with a specialist to discover nature's design strategies on form-performance; processes on how biological materials are arranged and ecosystem relationships.
- **Discover:** Design workshops to Identify an 'active design principle' based on form, process, and ecosystem relevant observations.
- **Create-Evaluate:** Developing an experimental research process with analogical models that emulates the identified 'active design principle'. Then successful explorations will be evaluated with models based on digital tools for parametric studies, performative-responsive interactions, and digital fabrication.
- **Implementation:** A brainstorming of potential applications will guide acquired knowledge to prioritize sustainable design proposals according to the decarbonization challenge.

The acquirement of the following skills, values, attitudes and abilities will be promoted during the course:

a) Develop skill set for innovation, creativity and collaboration

b) Team work to contribute in meaningful work

c) Reconnection with nature and bring it into professional and personal lives

d) Understand and generate sustainable biomimetic solutions

e) Turning to nature for inspiration

f) Design consciously

g) Oral and written communication

h) Interacting well with others, transdisciplinary and multidisciplinary connections.

i) Negotiating while inspiring trust and empathy

j) In-depth observing

k) Paradigm shifting

l) Ability to use environmental research, analysis and diagnostic techniques and methods.

m) Ability to discuss the importance Biomimicry.

COMPETENCIES CRITERIA AND EVIDENCE OF PERFORMANCE

For the Universidad Veritas competencies are reflexive and comprehensive activities that correspond to the professional profile and contextual problems correctly and with an ethical commitment, integrating learning to be, learning to do, learning to know, and learning to live together, within framework of continued improvement.

Both disciplinary and general competencies are presented, linked to their criteria and evidence of performance for the course on Sustainable Consumption and Production.

Type of competence	Performance criteria	Evidence of performance
-Students will be part of a learning process to develop the skills necessary to consciously and strategically emulate nature's genius. -Integrates the best international practices of bio design to develop solutions and detect opportunities considering comparative analysis of the developed prototypes	-Integrate biomimicry thinking into any sphere-specific opportunity resulting in biomimetic outcomes -Facilitate the integration of biology into design using biomimicry thinking. -Interpret observations in nature with a functional lens for design applications -Discuss the importance of bio design through best practices in real projects.	-Theoretical-practical sessions and group work between individuals of different backgrounds. -Discussion of issues through exchange, work and dialogue. -Creative processes -Design exercises -Discovering in field -Identifying challenge -Emulating nature's strategies -Interpret, design brief -Brainstorming
-Integrates knowledge, skills and attitudes to continuously learn and through one´s life pursuing an efficient development in the knowledge-based society.	-Learning to learn a new method of inquiry, a new set of lenses and a new humility	-Laboratory Practice Reports -Project presentation -Scientific article analysis -Field Trip Reports -Group and individual presentations
-Builds the necessary knowledge, skills and attitudes to learn how to communicate orally and in written form in the different disciplines that make up the curriculum.	-Communicate thoughts of the discipline orally and in written form.	-Laboratory Practice Reports -Project presentation -Scientific article analysis -Field Trip Reports -Group and individual presentations
-Integrates the necessary knowledge, skills, and attitudes to learn teamwork and leadership techniques.	-Execute teamwork and leadership.	-Laboratory Practice Reports -Project presentation -Scientific article analysis -Field Trip Reports -Group and individual presentations
-Integrates the necessary knowledge, skills and attitudes to learn interpersonal communication techniques.	-Relate well to others -Manage and solve conflicts -Negotiate reliably and empathetically -Speak responsibly -Listen attentively	-Laboratory Practice Reports -Project presentation -Scientific article analysis -Field Trip Reports -Group and individual presentations

LEARNING STRATEGIES

In general, this course is characterized by problem-solving and inquiry-based learning activities with which students formulate and test their ideas, draw conclusions and inferences, and pool and convey their knowledge in a collaborative learning environment.

A. Learning through interactions with other people, or social learning.
B. Project-based learning, or PBL, which focuses on giving an open-ended question and complex problem to a group of students and having them figure out the best solution to the problem.
C. Inquiry, prompt students to formulate their own questions.
D. Multiple intelligences, allow multiple interpretations and expressions of learning.
E. Hands-on activities.
F. Daily journal helps the students to better understand how their own experiences contribute to the formation of their theories and observational notes, and then comparing them to another student reiterates that different backgrounds and cultures create different outlooks, while neither is wrong, both should be respected.

G. Biomimicry tool. The intent behind applying nature's unifying patterns to biomimetic design is to create more sustainable solutions. Bio-inspired design can spur novel ways of thinking and breakthrough ideas, but only by considering nature's lessons in a systems context can we ensure that our designs will fit in well with life on earth.
H. Brainstorming. Problem solving with lateral thinking. It encourages people to come up with thoughts and ideas that can, at first, seem a bit crazy. Some of these ideas can be crafted into original, creative solutions to a problem, while others can spark even more ideas. This helps to get people unstuck by "jolting" them out of their normal ways of thinking.
I. Design Tables Currently students in disciplines such as engineering, architecture, materials science, organizational development, chemistry, and industrial design, among others tend to have very little biology training, and design challenges are addressed solely with tools commonly available within the specific discipline. Biomimicry breaks the barrier.

EDUCATIONAL RESOURCES

In order to facilitate learning and course development a range of recent bibliographic materials, multi-media equipment for individual presentations (with wi-fi access in each classroom), furniture and acrylic boards are placed at the disposition of students for weekly sessions and lectures coordinated by the professor to complement proposed teaching activities. The latter include the different learning techniques outlined herewith that optimize the student's ability to assimilate knowledge. Some of the lessons take place in the classroom, others, in order to improve learning, will take place in nature.

The student has physical access to the institution's Fab Lab and library during opening hours' study areas or computer labs and any other convenient area on the university's campus for individual study. Likewise, the university provides free Wi-Fi access to all students, professors and staff throughout the campus.

The university also places the CANVAS Learning Management System at the disposition of students and staff ensuring pedagogical flexibility making it easier to integrate new technologies into the courses, and ensure seamless and effective communications between the student and professor at all times through an app center.

LEARNING EVALUATION

In order to make the course or program better competencies based evaluation compiles and evaluates evidence by taking into account feedback providing pre-established criteria. The course evaluation must be aligned with the competencies and the teaching methodology. There is a rubric for each evaluation resources. Even though the rubric grants a grade, it is also a quantitative and qualitative description of the students´ performance. The rubrics include the core and discipline key competences.

RUBRIC	% VALUE
Final Presentation	30%
Field trip Workshop Report	30% (2 reports 15% each)
Team Design Workshop Research	40%
TOTAL	100%

Team Design Workshop Research

This project is 40% of the final grade. The professor will provide guidance through the project. The assignment consists of group design research and each group member must participate actively during process.

Indicator	Excellent	Very Good	Good	Needs Improvement	Not Achieved	Observations
	5	4	3	2	1	0
Biomimicry -How well do you demonstrate and document an understanding of function and biological strategies? Did you effectively identify relevant biological strategies applicable to your design challenge? -How did you determine and prioritize the strategies most relevant to your design? -How well do you show a clear connection between a biological mechanism, form,process, pattern, or ecosystem, and how the design concept submitted to emulate that natural model or models?						
Design process -How well do you develop an experimental research process with analogical and digital models that emulates the identified 'active design principle'. -How well do you evaluate generated models based on digital tools for parametric studies, performative-responsive interactions, and digital fabrication.						
Context and Relevance -How well do you define your specific mentor? -How well do you understand the ecosystem to inform design criteria? -What are the performance benefits of your design active principle?						
Impact & Feasibility -Does your design concept represent a promising solution, in comparison to others? -Will your design lead to significant sustainable positive changes?						
Creativity How novel is the innovation and/or biological inspiration?						
Communication Your submission provides a comprehensive understanding of the design process?						

Field Trip Workshop Report

This project is 30% of the final grade. Field Trip workshop contains information about what the students see and learn in the field and personal opinions based on knowledge and observation. There are two reports 15% each; assessment is performed using the following rubric:

Indicator	Excellent	Very Good	Good	Needs Improvement	Not Achieved	Observations
	5	4	3	2	1	0

Report 1: **Sensing activity to 'identify' a Mentor** (Use the senses other than vision to learn about creatures and their functions). -Genius in place activity: Document a champion/mentor. Sketch, diagram, Function, Natural History, Strategy Mechanism, Life Principles, Application Ideas. -Exploring Scale Activity: Grab your journal. What is expected: -Selection of a specific mentor. -Use referential sources (when needed) are presented using APA style last version both inside the body of the report and in the bibliography section. At least 4 bibliographic sources were consulted. -The report is clean and organized, and shows good spelling and punctuation. -How well does the student demonstrate and document an understanding of the activity.						
Report 2: Methodology into action **Identify:** use nature's design strategies on form-performance; processes on how biological materials are arranged and ecosystem relationships on the 'mentor'.) **Discover:** resume relevant observations upon an 'active design principle' based on form, process, and ecosystem. **Create:** Developing an experimental research process with analogical models that emulates the identified 'active design principle'. What is expected: -Develop of a research process -Use referential sources (when needed) are presented using APA style last version both inside the body of the report and in the bibliography section. At least 4 bibliographic sources were consulted. -The report is clean and organized, and shows good spelling and punctuation. -How well does the student demonstrate and document an understanding of the activity.						

Final Team Presentation

This project is 30% of the final grade. The final presentation comprises all final research outcomes based on a comprehensive presentation of the design process. Members of the class not presenting act as a public and together with the professor ask questions to the presenters about the topic. These questions will be asked randomly. Presenting time plus questions and discussion will be 15 minutes' maximum, depending on the amount of students enrolled.

Indicator	Excellent	Very Good	Good	Needs Improvement	Not Achieved	Observations
	5	4	3	2	1	0
Biomimicry Knowledge -Dominance on the topic is demonstrated when answering professor and peers' questions. There is a balance between the amount of text and images in the presentation, and the student is independent of						

written material. -The team exposes own point of view about the analyzed topic, using robust foundations that reflect the research on the topic and the understanding of the information						
Research Process -Analysis is evidenced in the presentation as a well-established relation between the contents approached in class and the investigated information.						
Impact & Feasibility -Does your design concept represent a promising solution, in comparison to others? -Will your design lead to significant sustainable positive changes?						
Creativity How novel is the innovation and/or biological inspiration?						
Communication Your submission provides a comprehensive understanding of the design process?						

TEAM

Michael Smith Masis is the founder and co-director of the award-winning practice Entre Nos Atelier based in San Jose, Costa Rica. The practice encourages participation, collaboration, cooperation, and ownership by low-income residents, rural and indigenous communities, and informal settlements, the true protagonists in the city. Projects are guided by principles of replicability, efficiency, functionality, feasibility, and environmental sustainability. His work has received the Young Architects in Latin America Award, 2017 CICA Award for Young Architects Practice, 2015 International Architecture Award at the Buenos Aires Biennial of Architecture, 2016 Grand Biennial Prize, and the 2016 and 2014 Icomadera Prizes and the 2015 Sustainable Construction Award in Costa Rica. A graduate of the AA SED Masters program in 2008 Michael Smith is currently a Loeb Fellow at Harvard University's Graduate School of Design.

Tomas De Camino is the co-founder of the Costa Rica Foundation for Innovation. He was the Director and founder of the research center for the innovation, Universidad Veritas. He has worked as a professor at the University of Costa Rica, Technological Institute of Costa Rica and University Veritas. He is an associate researcher at the research center in mathematics pure and applied in the UCR and has published more than 20 articles in magazines of Prestige and written several chapters of books. In 2008 he won the Lee Siegel Prize from the Springer publishing house, for having published the best original article in the area of mathematical biology in the period 2006-2008. He has participated as a jury in innovation and entrepreneurship events in Costa Rica and Mexico

Rebeca Mora is a member of the Biomimicry Global Network since 2015, founder of Biomimicry Costa Rica: la Biblioteca Verde and the only Biomimicry specialist graduate in Costa Rica. She works in research related to the subject at the School of Architecture, Research Center in Materials Science and Engineering (CICIMA) and the School of Biology of the University of Costa Rica where she is currently finishing her PhD thesis on the topic. Her doctoral research focuses on color patterns in nature through diverse methodological approaches within the areas of physics and biology, implementing

insects as study models, with various publications on the subject. She has extensive academic experience in Biology and, more recently, Biomimicry. She worked with PROINNOVA, the technology transfer office of the University of Costa Rica, as coordinator of Innovation Managers. In 2011, she graduated as a Biomimicry Specialist from the Biomimicry 3.8 Institute. Now serves as a consultant and professor at the University of Costa Rica, and was chosen as a TED speaker in our country last year.

Rolando Madrigal is a professor at the School of Architecture at Universidad Veritas.

Mariano Barrantes is a professor and research at Universidad Veritas' Center for International Programs & Sustainability Studies. His Licenciatura thesis focused on conservation of the populations of the jaguar (Panthera onca) and its prey in the north of Costa Rica. As a professional, he has experience in mammal conservation, field biology, environmental education, beekeeping pathology and as a consultant in the fisheries sector of Costa Rica. He has also collaborated with different NGOs whose purpose is the conservation of felines and their habitats. He is currently pursuing a Masters in Environmental Project Management and further research lines in Costa Rican Felides.

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