AST

20.201
Architecture Science
and Technology

2020

Coursework 2018-19

Michael Budig
R^{E}AL Renewable Architecture Lab

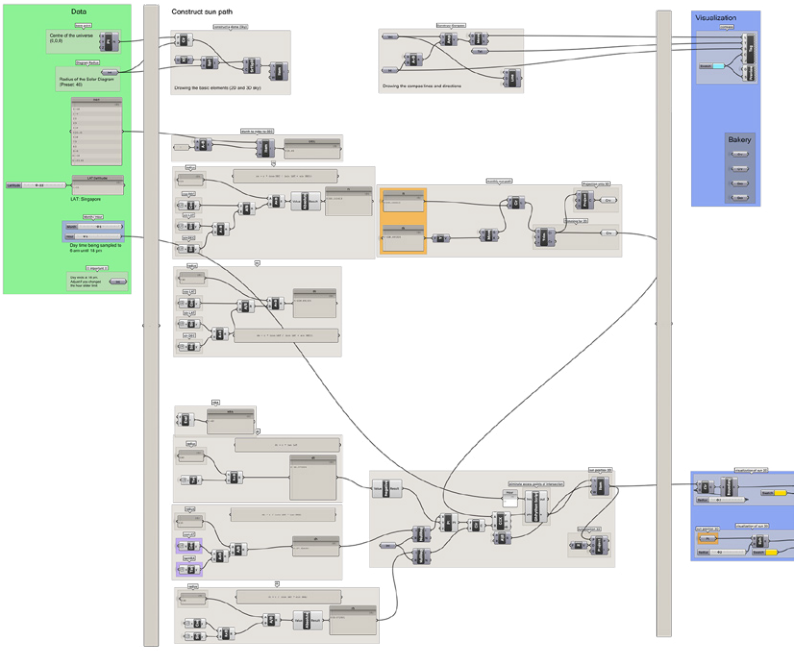
Architecture Science and Technology / Term 4

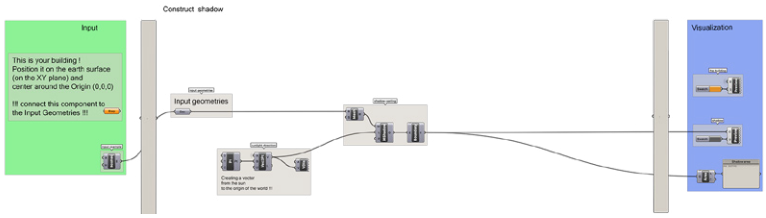
Technology and Design

Architecture Science and Technology provides an introduction to Building Technologies and is conducted in Term 4, the first term in the Architecture and Sustainable Design Pillar. It discusses the applications of technology and physics in architecture and synthesises them with construction methods and material choices in a series of design challenges. These sequentially build up on each other and lead to the elaboration of the construction design for a small building. Each sequence is introduced in weekly lectures and then further examined and applied through the use of parametric and visual programming tools in the subsequent lab sessions. This process aims for two distinctive learning experiences: on the one hand, the composition of these tools are based on physical principles and scientific knowledge. They are demonstrated so that students can identify the underlying logics. On the other hand, these tools are parametric and hence support intuitive learning by enabling any design modifications to be visually assessable and quantifiable.

The individual challenges start with the exploration of a building's environment on a broad scale through the study of climatic conditions and how architecture can respond. This centres around the impacts of solar radiation and wind. In the subsequent phases, the topics zoom more and more into the building by shifting the focus on continuously smaller scales. Building systems are introduced next to describe and classify the various types of components that are required to assemble a building. Foundations, superstructure, infill systems, building envelope and technical infrastructure are addressed. When structural systems are discussed, basic principles of statics are presented in both conventional calculation and graphic static methods. This provides fundamental knowledge for the second core course on building technology, when structural design and assessment will be taught in more depth. In a next step in this course, building materials are investigated and respective choices are compared in their thermal performance and ecological impacts. The various aspects are eventually integrated in the formulation of construction design concepts for a small building.

The ultimate goal in Architecture Science and Technology is to use technology, navigate between quantitative and intuitive modifications, and synthesise the complex forces that act on a building in a design proposal.





Toolkit
The course is going through a series of assignments that follow up on each other sequentially. They are all based on tools that are built in the lab sessions and support both an intuitive understanding as much as quantitative assessments of the impact of physical forces on buildings.

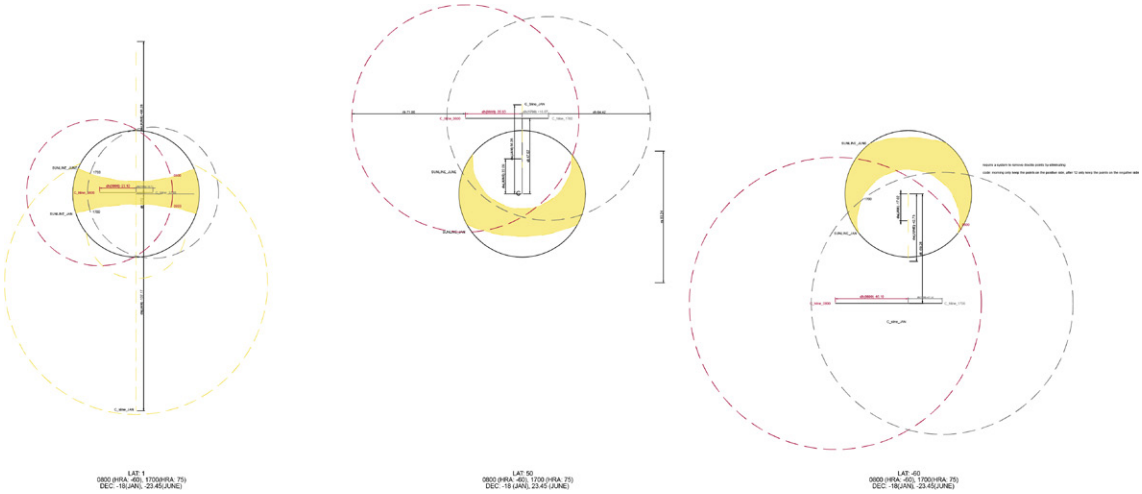
The first part of this toolkit builds a solar diagram for climatic analysis, the second a structural frame, the third supports ta prediction of the ecological impact, and the fourth generates a diagram of a thermal transfer through a building component.

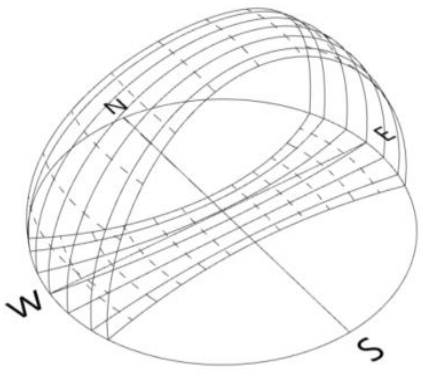
Solar Diagram Phuket, Thailand
Main Climate
Equatorial Monsoon

Longitude and Latitude
8.11320, 98.31687

Annual precipitation:
199mm

Mean temperature:
27.6 degrees Celsius





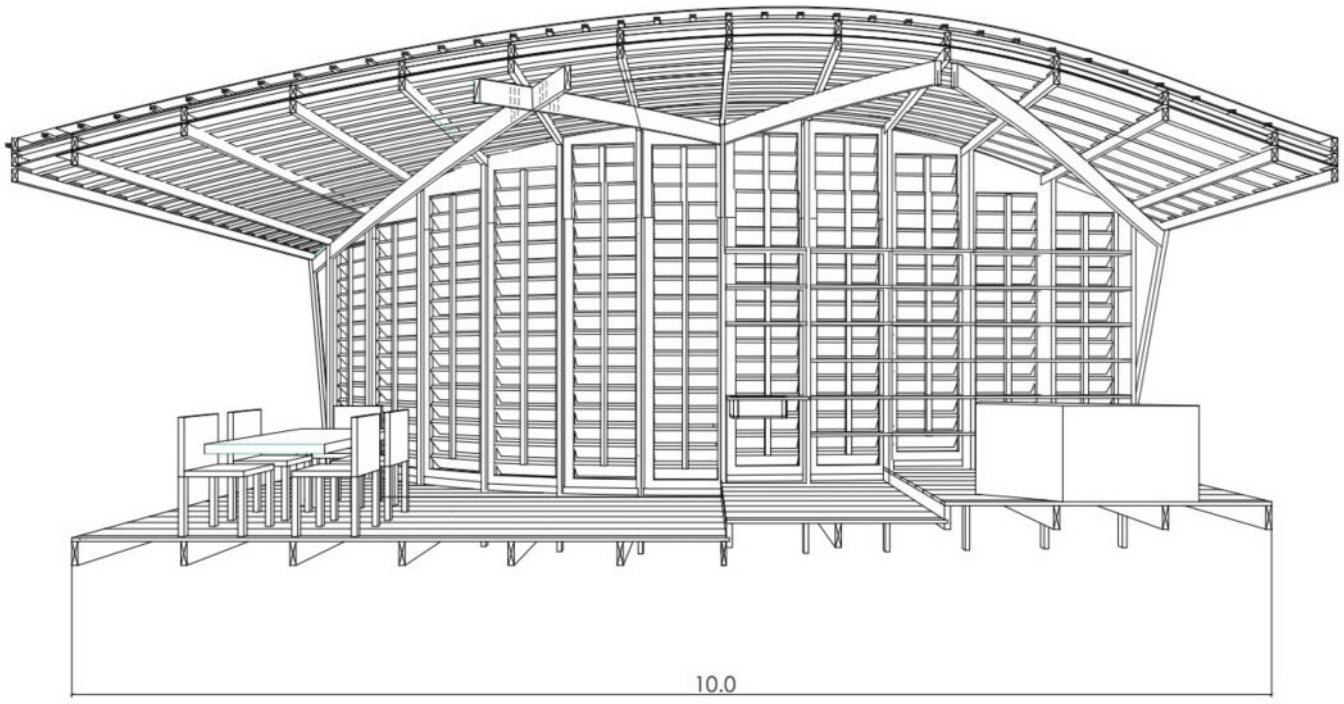
Images on right page, student work 2019
Transformation from abstract volumes as climatic design studies to articulated structural systems

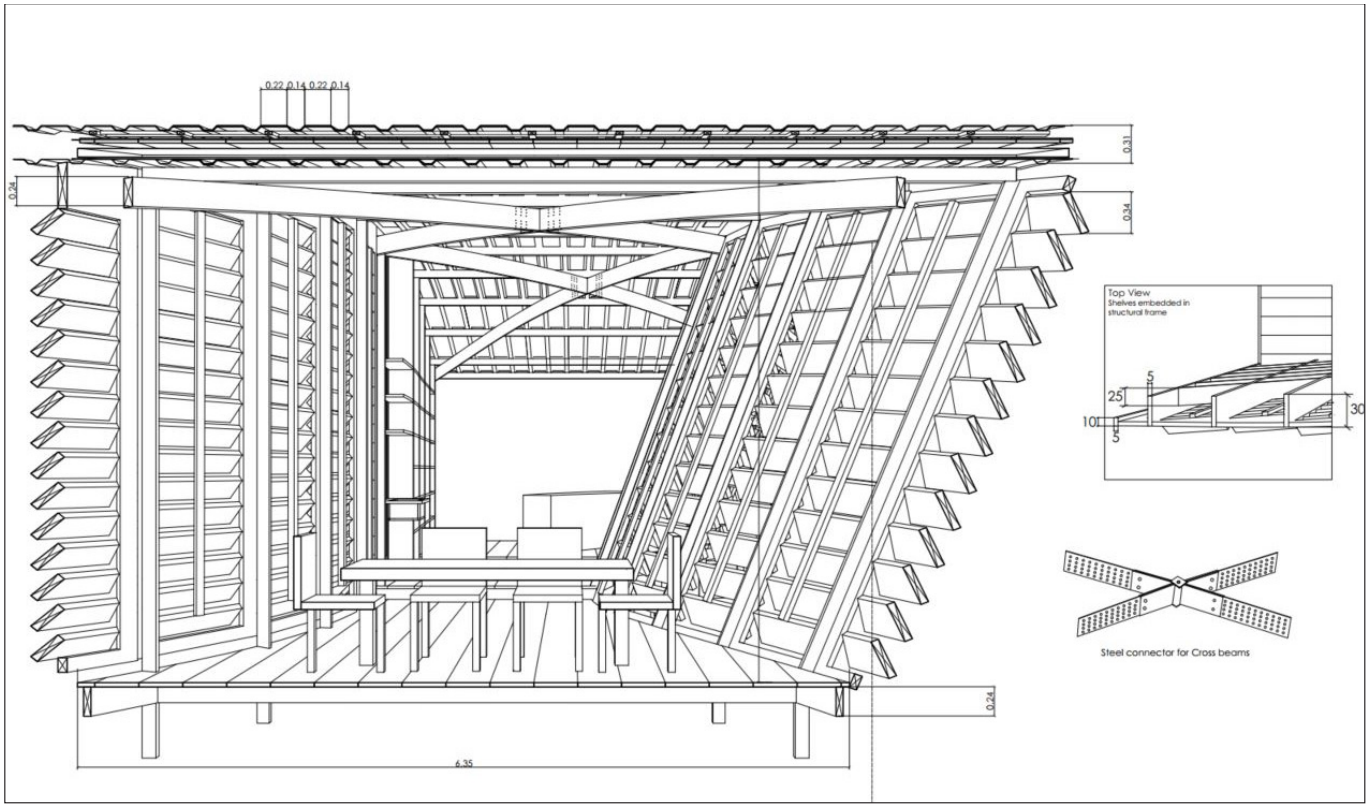
Sustainable Design

Buildings contribute to almost 40% of the total global Greenhouse Gas (GHG) emissions, commonly described as carbon footprint. As a consequence, architecture and in particular the aspects concerning building technologies are facing a massive challenge. In return, they offer immense opportunities and any actions in architecture can be significant in order to contribute to a reduction of our ecological impacts. A large part, a little less than 30% of the total emissions are caused by operating buildings, which includes water and energy consumption. These portion is referred to as operational energy. It is mostly affected by a building 's technical infrastructure, and can to some extent be mitigated by passive design considerations such as shading devices to prevent overheating.

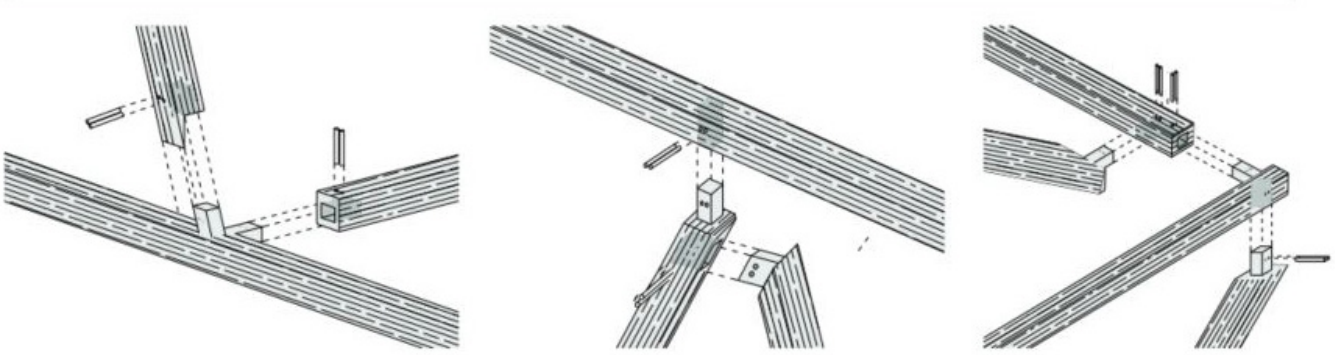
The first design tasks in this course addresses passive design as a means to environmentally conscious solutions. The area of energy design will be elaborated in depth in the third of the core building technology courses, on architectural energy systems. Whereas this field has been receiving a lot of attention and has made technological advances leading to lower ecological impacts, the study of materials and the consideration of embodied energy has made less advances. All energy consumed and the Greenhouse Gasses emitted during the sourcing and processing of materials, the production and manufacturing of components and the assembly of a building are subsumed in the Embodied Carbon (EC). Once a building is finished, there is little further change to this unless parts need to be maintained or a building undergoes renovation or adaptation. Yet this portion represents 11% of the total GHG emissions, and by looking at material choices in the context of structural and thermal behaviour, this course looks at the impact of different design decisions.

Architecture Science and Technology addresses decarbonisation as a pressing challenge in the built environment, fosters analytical skills and motivates a critical discourse on design choices and the impact of technology on the environment.





Illustrations by students 2018
Chiew Jia Hui
Paris Lau Shernese
Yoo Fei Yi
Wong Chai Qin

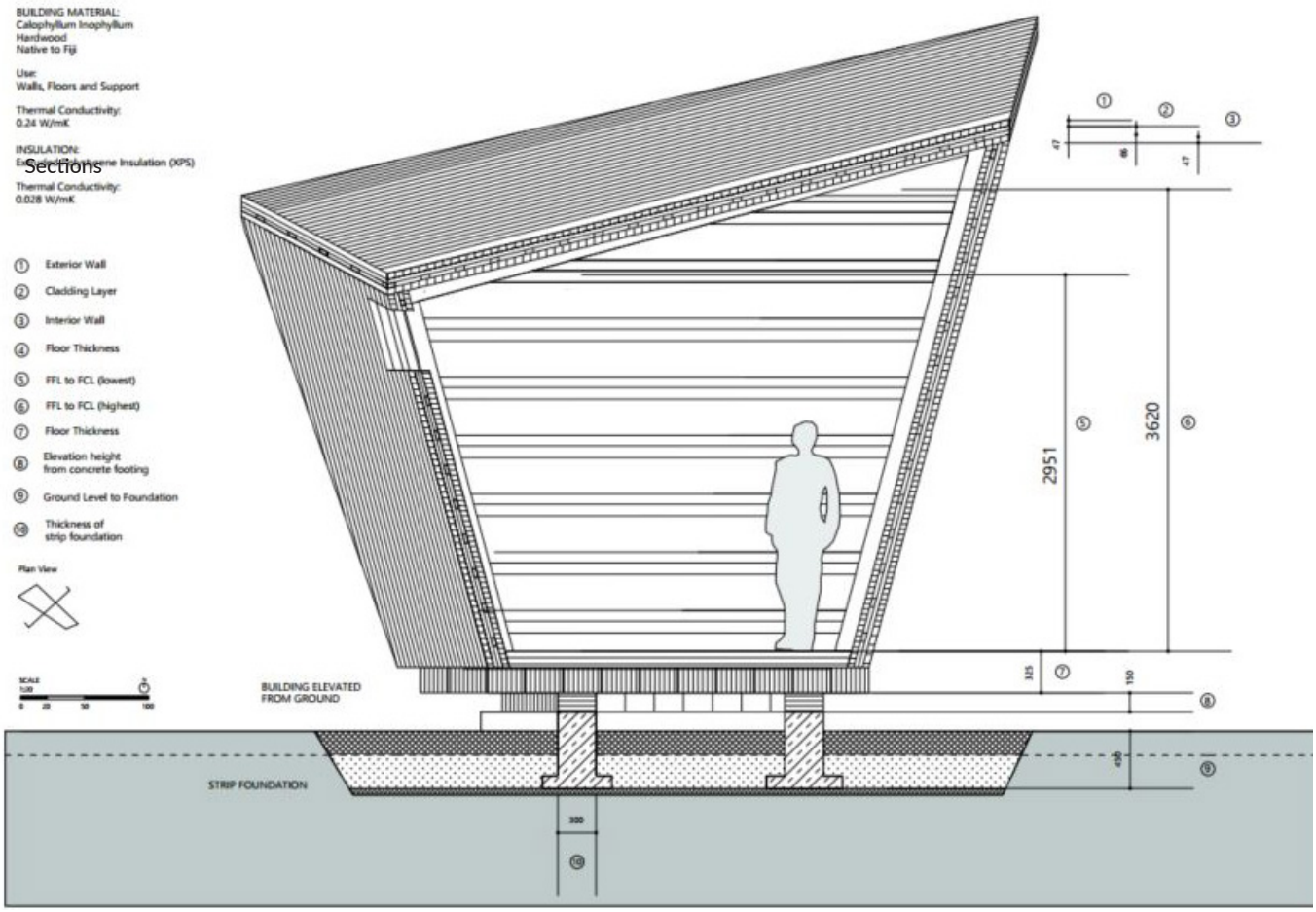


Base frame joinery

Roof joinery

Corner roof joinery

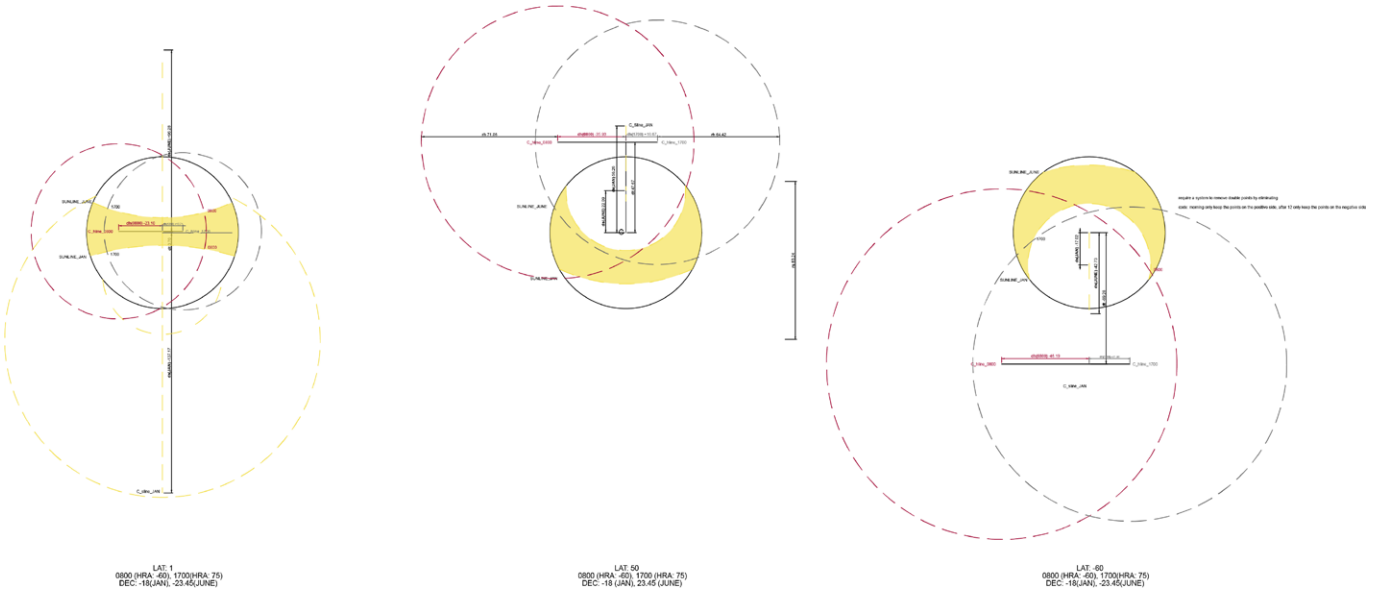
Sections

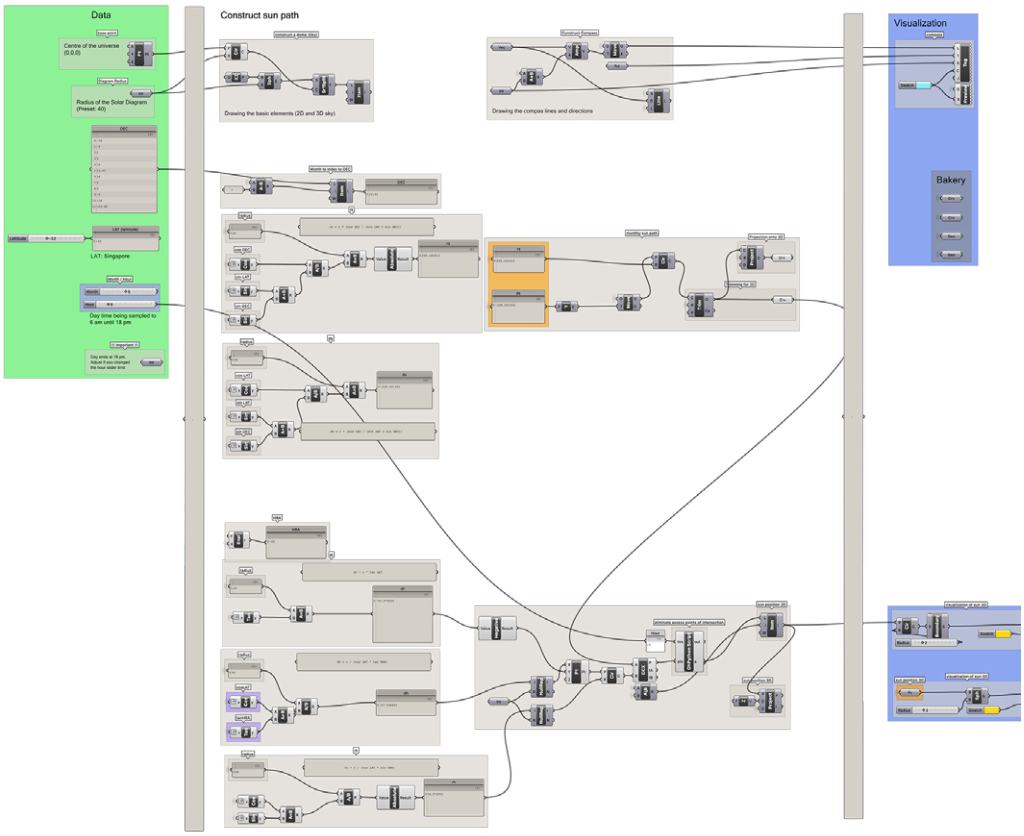


Illustrations by students 2018
Benjamin Chong
Tay Boon Kiat
Sean Lee
Teo Shao Tian

Architecture Science and Technology / Term 4

Architecture Science and Technology equips undergraduate architecture students with essential knowledge on building technologies and a sensitivity for good workmanship. Like craftsmen need to profoundly understand the material and tools they are engaging with, architects have to develop and refine the integration of structural logic, construction methods and tectonic articulation. A sequence of consecutive lab projects allows participants to navigate between measurable and intuitive modifications, identify the forces that act on a building and synthesise the complex demands of a design by developing detailed information construction proposals. The goal is to utilise and critically reflect on technology, by exploring the performance of buildings in different climates, categorising building systems and respective construction systems, examining structural integrity and formulating conscious material choices. The course addresses decarbonisation as a pressing challenge in the built environment and establishes an informed discourse on design choices and the relation of buildings with their environment.





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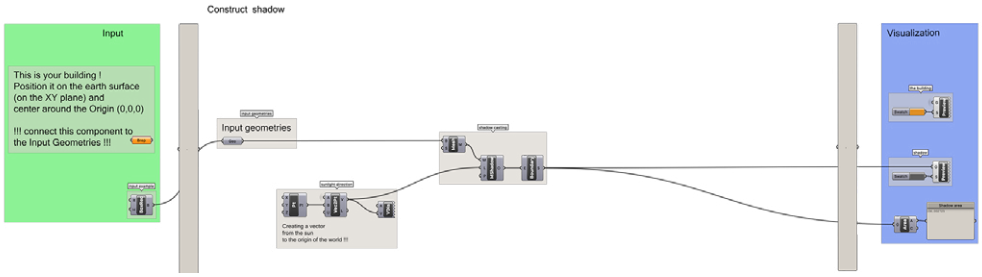

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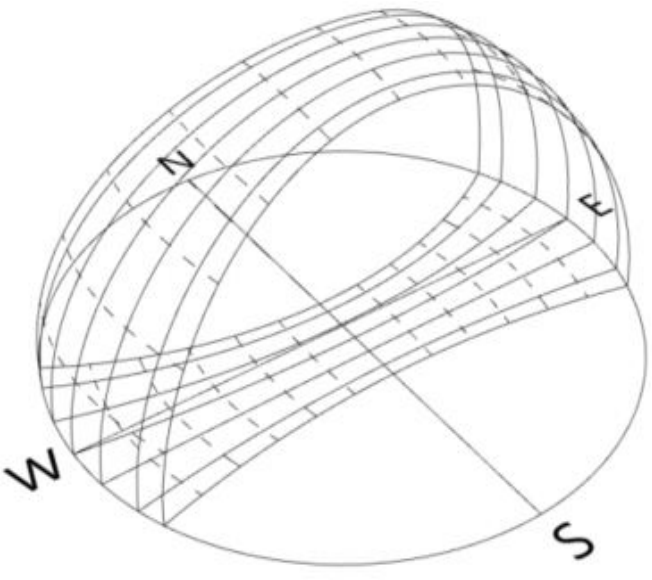

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