The Structure of Architecture

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Territory of Investigation:
Architecture + Representation

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Abstract

The “structure” of the architecture has always been an inescapable term, for here I do not mean the bearing structure of building-although sometimes they are inseparable, but rather the underlying structure-namely those factors that determine the configuration of architectural elements such as bearing wall, columns, and partitions. The way architect composes space is never a simple addition of mannerism, is neither a redundancy of ornaments; instead, they are systematically constructed, carefully integrated, clearly articulated in order to represent a conceptive reality. The three semester’s design studios and electives had deepened my understanding of this very theme in architecture. This short essay, as an investigation of different concepts, from the very first column in history to the carbon-driven present, try to capture the structure of architecture- elusive but dominant in representing the concepts, thinking, reflections through plans, sections, and et cetera.

Architecture and Representation is my territory of investigation. Representation is first and foremost about drawing but far beyond drawing, the necessity of knowing how to draw values more than simply to draw. In this paper, the structure underneath those representations was discussed and analyzed-they all dedicated to a narrative, a story, and a reality.

Since the very beginning of architecture, the representative nature has embedded in the first column. It is said that the very first column was an imitation of sacred tree groves. At that time, people conceived trees as a host for the holy spirit. Thus as the residence of those primitive gods, trees were the necessary elements to be integrated, adored, and worshiped in the sacrificial landscape-temples.

In the lost meaning of classical architecture: Speculations on Ornament from Vitruvius to Venturi (1988), George Hersey systematically investigated how those fundamental ideas, concepts considering sacrifice activities were translated into the formation of the specific architectural elements. The story behind those complicated decorations-metopes, triglyphs, mutules and regulas was not the improvisational performance of mannerism, but a systematically constructed representative reality.

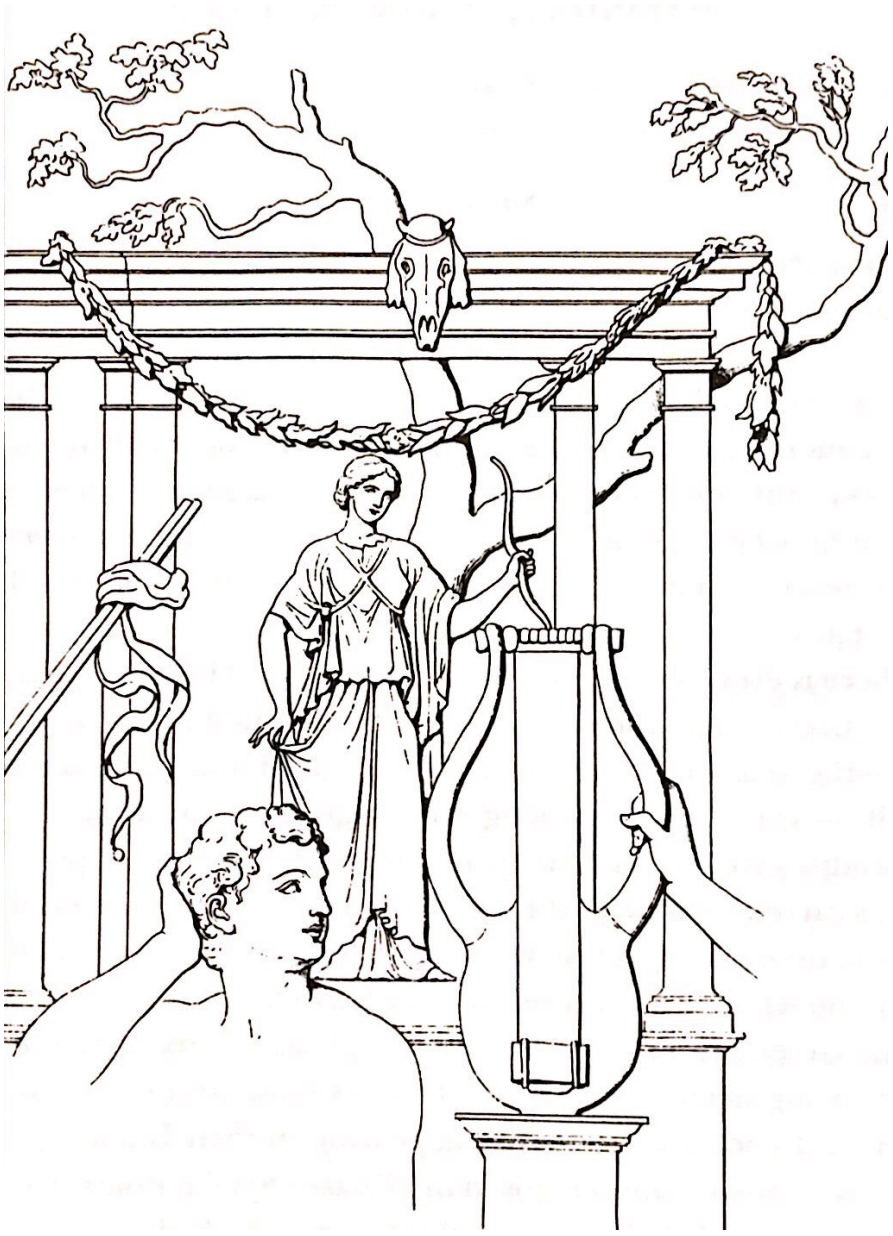


Fig: Tree aedicule of Artemis. From Carl Boetticher. Der Baumkultus der Hellenen. 1856.

The conception of the circle has assumed much meaning in western history. Numerous models were constructed to repair the discrepancy between observed astronomical phenomenon and ideal geocentric model, and it becomes so sophisticated in a way that the simple aim is to maintain the appearance and existence of circle. The multicentered characteristic of Renaissance architecture was the ultimate expression of the way people in the age of humanism conceived the universe.

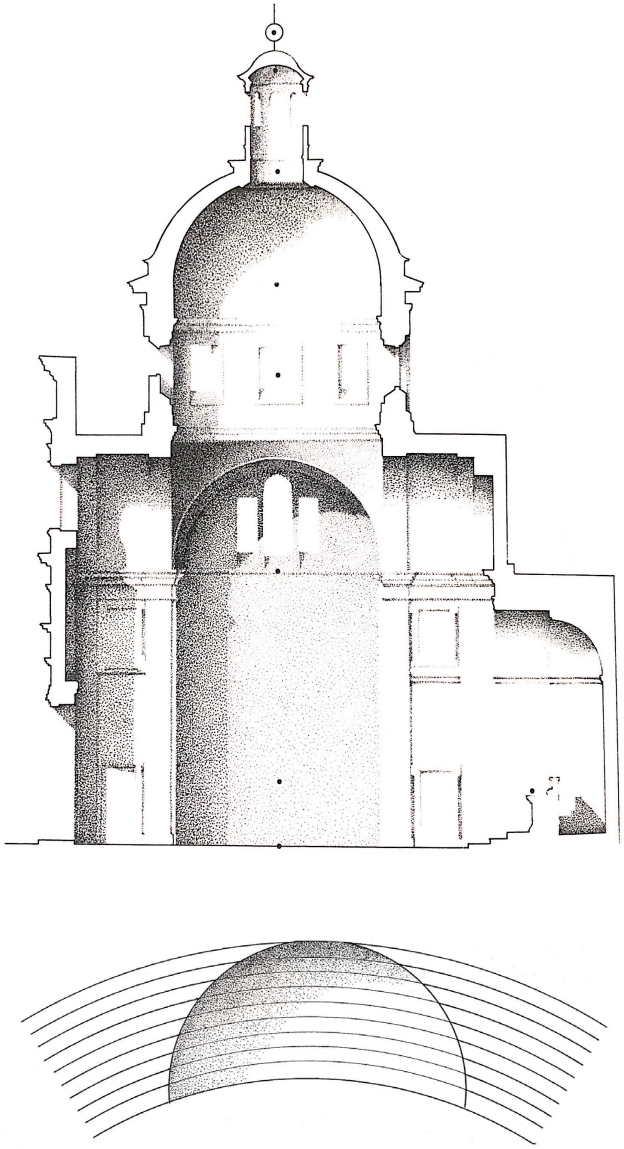


Fig: Multi-Centered Composition of Renaissance Church(Sant' Eligio degli Orefici). Evans, Robin. The Projective Cast: Architecture and Its Three Geometries. Reprint. Cambridge: MIT Press, 2000.

To Mies van de Rohe, the conception of structure concerned more with the general organizational rules of architectural elements, such as the column, wall, and pavement. In the elective architecture, space, structure, we discover the underlying rhythm behind the appearance of architecture plans.

The ratio of 1:2 permeated into every scale- from the smallest unit to the most significant division of the building elevation. It regulated the placing of the core, bearing wall, partition, column, millions and even pavement. The structure in this meaning is one single regulating rule that can give birth to a whole range of architectural elements on different scales. It places more emphasis on the unity of the system rather than the expression of load bearing structure only.

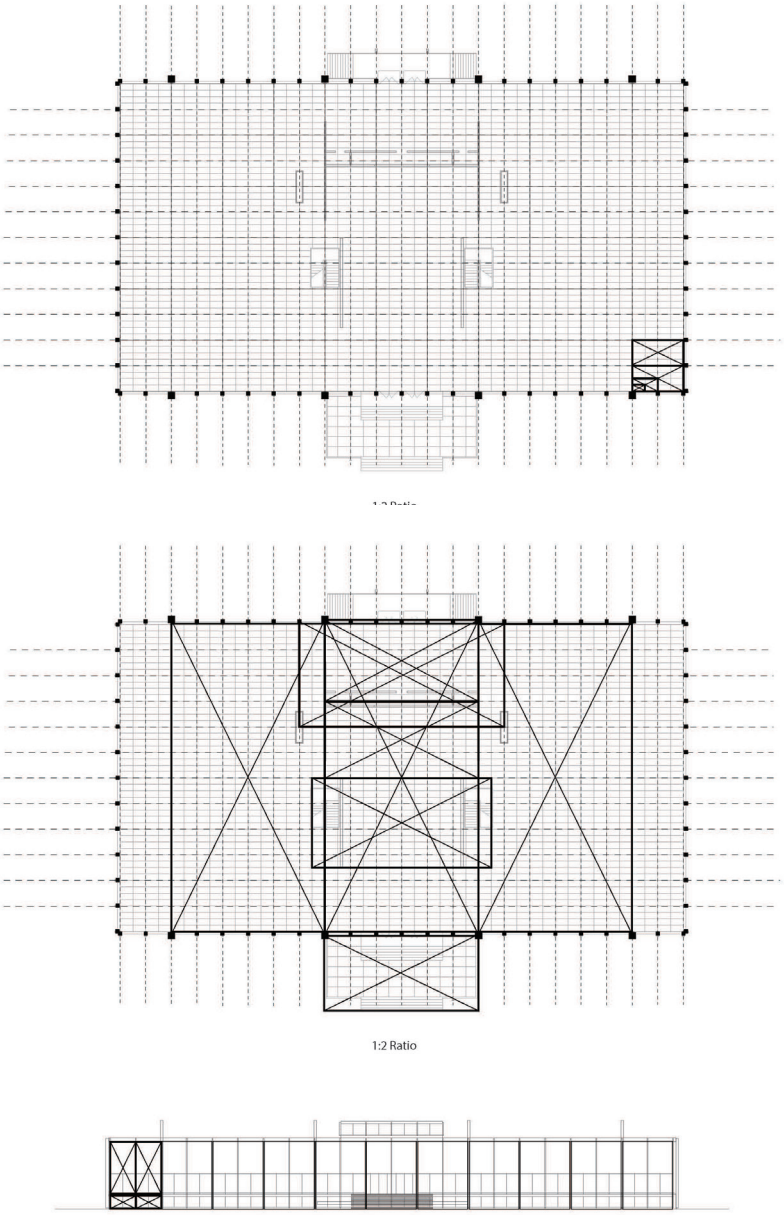


Fig: Crown Hall Plan Structure, Elective Course Architecture Space Structure, Cornell AAP Fall 2018, Instructed by Maria Claudia Clemente, Francesco Isidori.

Different from modernist figures, the way structure appeared under Aldo Rossi's definition always relates to the idea of permanence, immobile but flexible to exterior variation. Rossi always describes the hall of Palazzo della Ragione in Padua, this giant hall as the living room of the city can cater diverse activities in different historical periods, although the structure was just the load-bearing system, the capability of it to transform, mutate and vary becomes the critical comparison of these seemingly immobile parts. The typological transformation of the Roman forum in those European cities again reinstates the immobility and permanence elements that remain after the rinsing of time. The structure under Aldo Rossi's definition has more to do with collective psychological things rather than simple architectural structure.

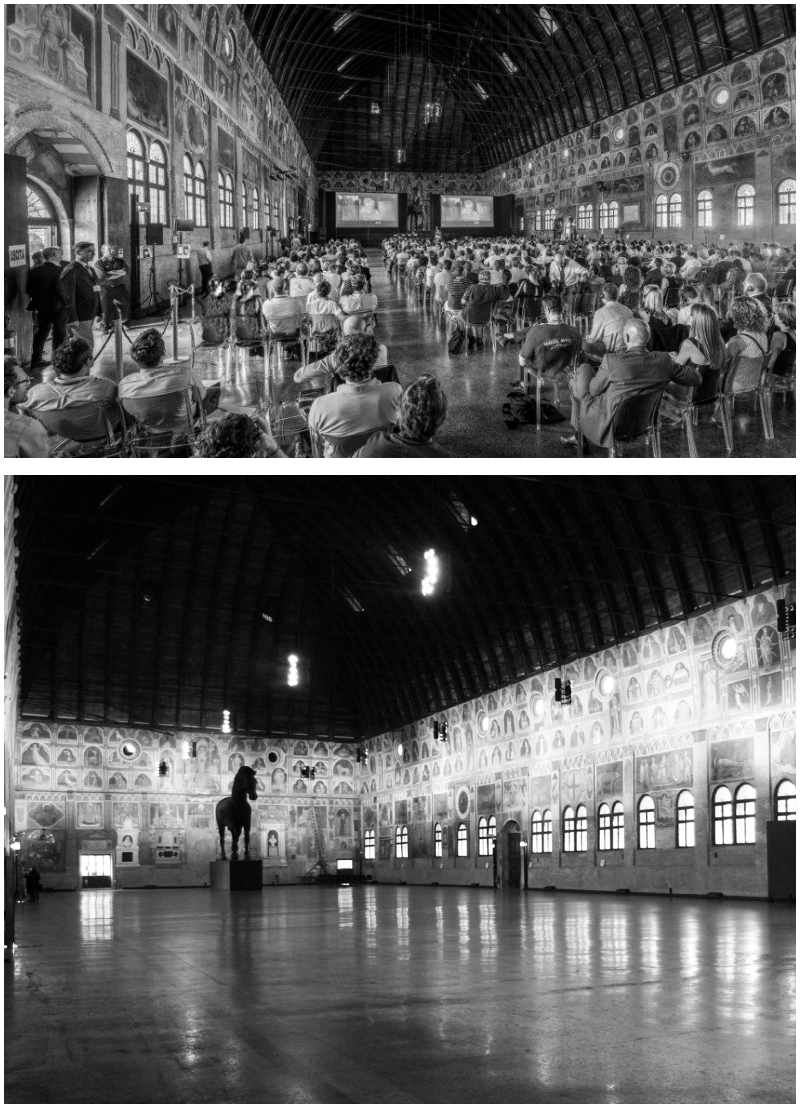


Fig: Palazzo Della Ragione Interior. Berthold Werner. 2009

The American typical plan style represented the outmost obliteration of architecture- this relentless extending, yet sheer singular column grid was the ultimate manifestation of capital and inhumanity. This simple logic- core, and floor began to proliferate in the office building. When it comes to high-rise buildings, the bearing wall and core are again valued a lot since they are indispensable elements that exactly make the high rise possible, yet they are the total opposite of those free-floating floor high above. The structure in this sense is related to calculating and mediating between structural possibility and plan flexibility. From here, the structure idea was gradually evolving as maximizing the efficacy of office building.

The appearance structure- namely those core and building wall-was not determined by some sublime ratio or proportion, either they become the result of the deep structure- those regulations, laws, constraints on site. These invisible data come from the site dominates the practice of architecture. Although bearing wall is stable and constant, they are the foundation of the unstable and flexible plan.

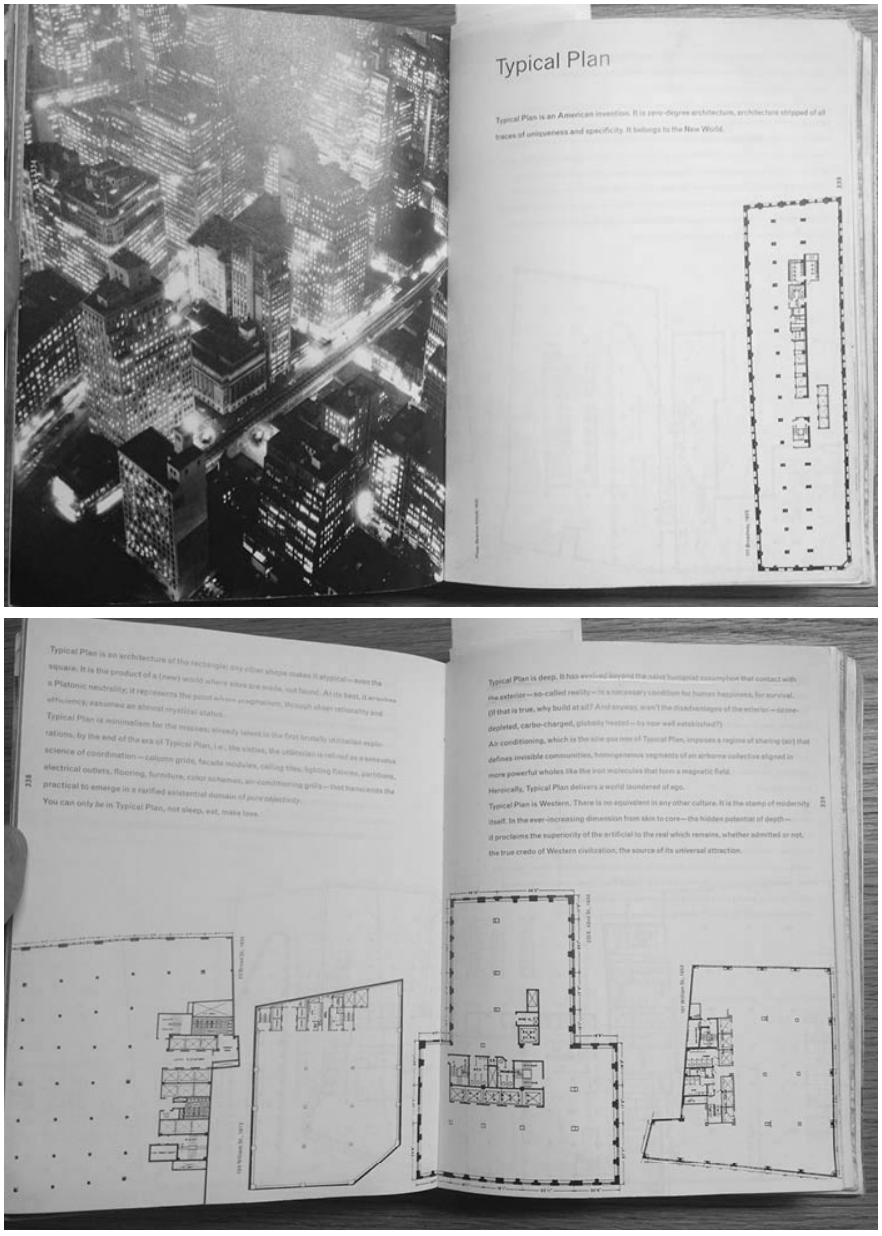


Fig: Office for Metropolitan Architecture. Small, Medium, Large, Extra-Large: Office for Metropolitan Architecture, Rem Koolhaas, and Bruce Mau. Edited by Rem. Koolhaas, Bruce. Mau, Jennifer. Sigler, and Hans. Werlemann. 2D ed. New York, N.Y.: Monacelli Press, 1998.

Nowadays, parametric design has reshaped the building design process. The information flow served as input to simulate, regulate and design a building. The structure of design has embedded in the process of design- namely those dominant factors that influence the generation of building.

City in a digital era is a conglomerate of innumerous datum. The building becomes a matrix to absorb, mediate, consolidate those unstoppable data streams. The structure of the building shifted from representing a clear stated idea to an amorphous palette between those various factors. The process is valued more rather than the outcome.

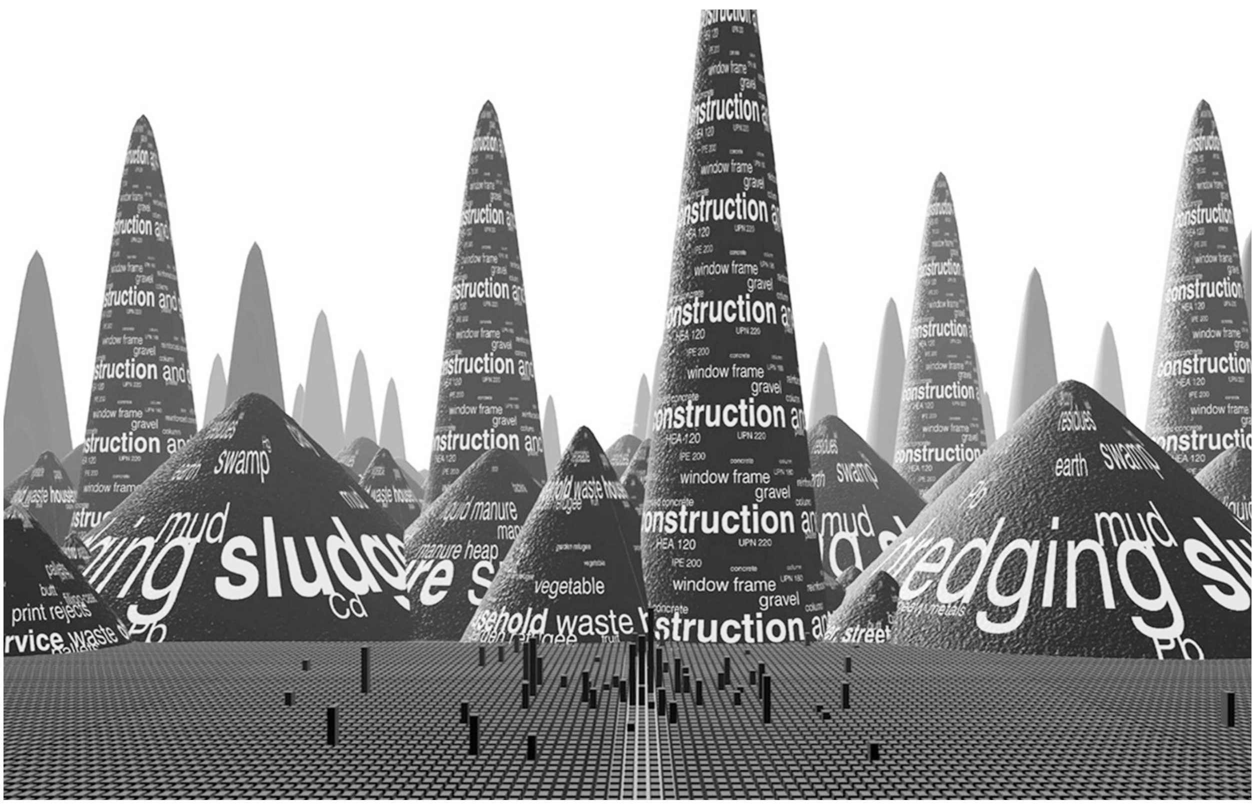


Fig: MVRDV. MetaCity. Collage. 1999

The embodied carbon and operative carbon nowadays becomes the new building metrics inscribed in numerous architectural regulations, the model to simulate the carbon flow in a whole life cycle measured building in a completely new way different than the previous standard. We emphasize reducing the carbon emission, including choosing the material, planning transportation, simplifying construction and reducing energy loss. All of these practical actions happening on different levels are serving the goal-cutting the carbon emission from the building sector. The placing and determining the actual location of the bearing structure is just a result of different simulation factors interacting with each other.

What is more important is that many LCA methodologies have the framework to calculate or simulate the carbon footprint of one product or process. However, they are unable to predict the actual data that one single item consumes on a particular site. This kind of data is highly contextual, contingent and depends on many factors. For example, to calculate the carbon footprint of a simple wood fiber insulation board on a construction site in the USA, we need to consider whether those wood fibers are coming from the recycling plant, whether they are transported by carbon-free vehicles, whether the wood factory adopts renewable energy and where they are transported . These tiny, trivial yet massive data remain underdeveloped in many LCA simulation software. The discrepancy contains highly possibility of error. Thus the necessity of mass computing, analyzing and processing the data related to carbon emission activity is of high value in the topics of architectural discipline today. In here the structure of plan in the sustainable design discourse shifts from the pure mathematical deduction, instead becomes more elusive embedded in those layered of programming. The program itself becomes the representation of the digital era.

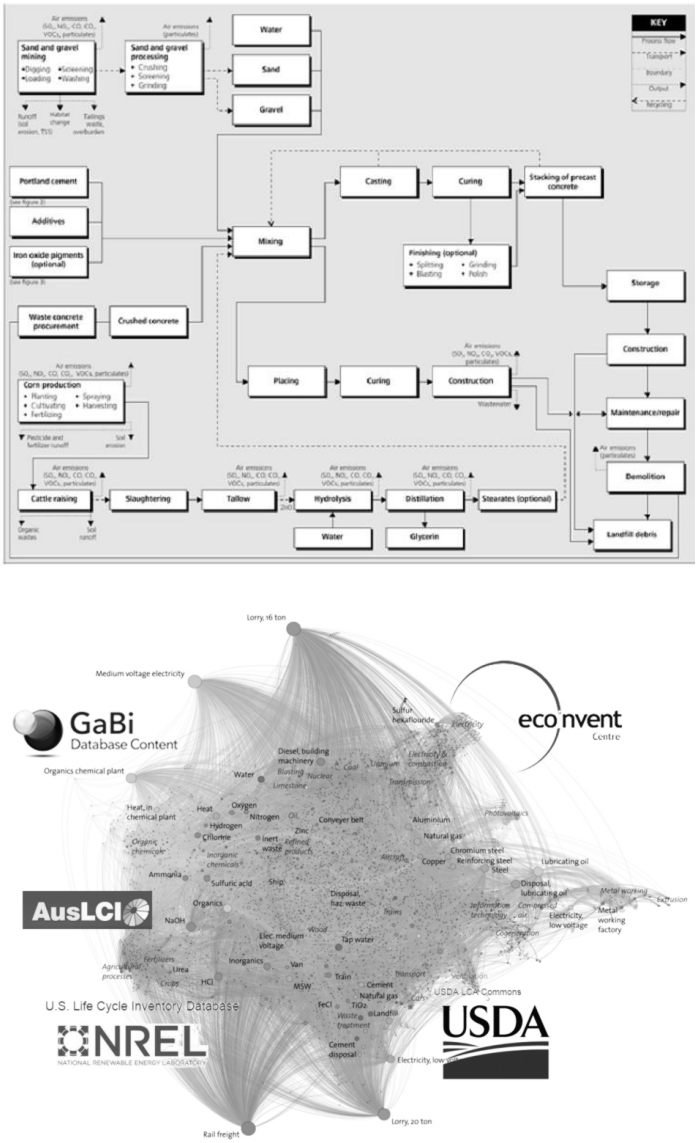


Fig: American Institute of Architects. Environmental Resource Guide. John Wiley and Sons. 1997. LCA Data Complexity. https://www.ipoint-systems.com/blog/success-factors-for-life-cycle-assessment-data-data-data/. 2016

In elective course “Rethinking Timber System” instructed by Katharina Kral, from analyzing and modeling the material performance in existing building examples, the irregular shell structure of timber was examined. The aim of the course was reconsidering its possibility to make high rise buildings in the future. A series of parameters were set as the rules of design variations, such as floor height, inclination, opening, and beam height. By evaluating the stress utilization of and the displacement of timber, the design process itself is morphed into the consistent test and trial process- generated little by little and finally arrived at a different qualitative status. The structure of the design, in this case, is more related to the definition and relationship between those dominant factors set in the first place. The same kind of thinking was also visible in the proposal for robotic architecture, the organization of system and relationship between those different movement factors acts as the generative rule of design. The design is the combination and calculation result of those relating process.

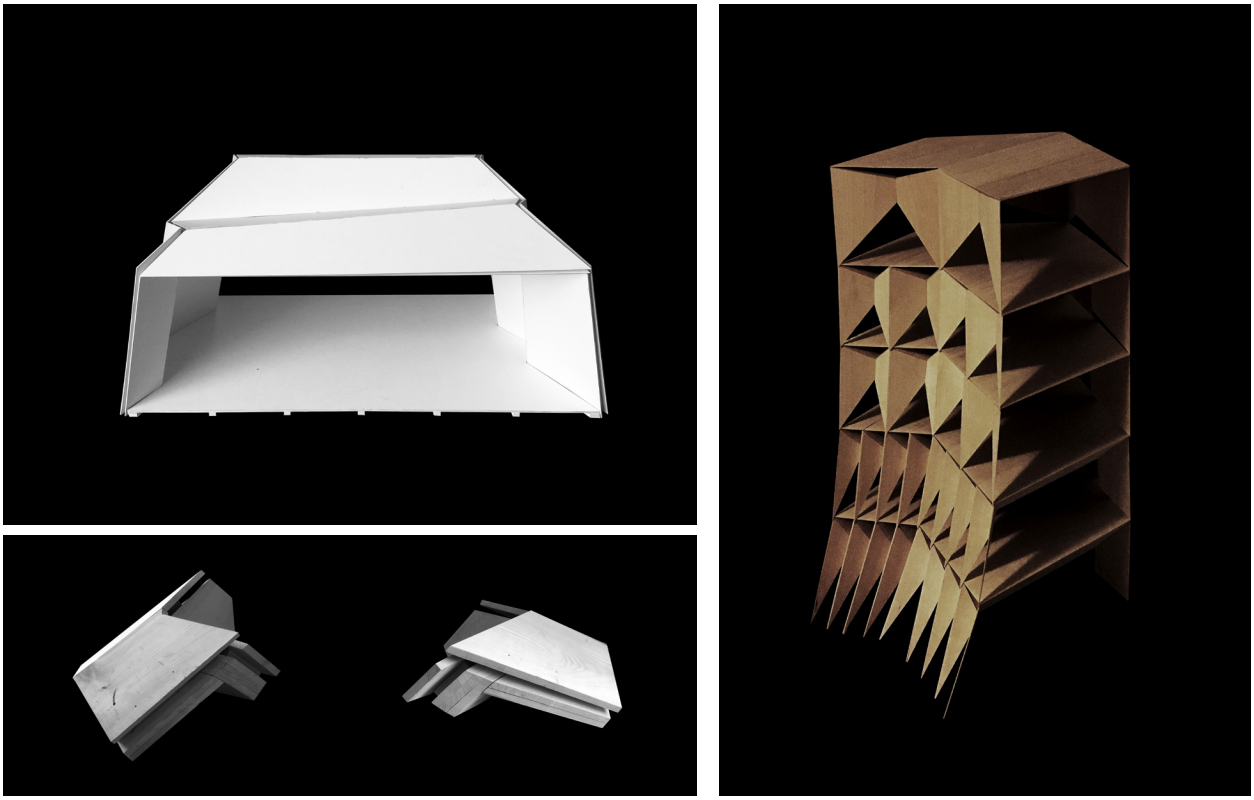


Fig: Recessing Skirt. Study Model, Joint Model and Final Model. Elective Course Rethinking Timber System. Cornell AAP Fall 2018. Instructed by Katharina Kral.

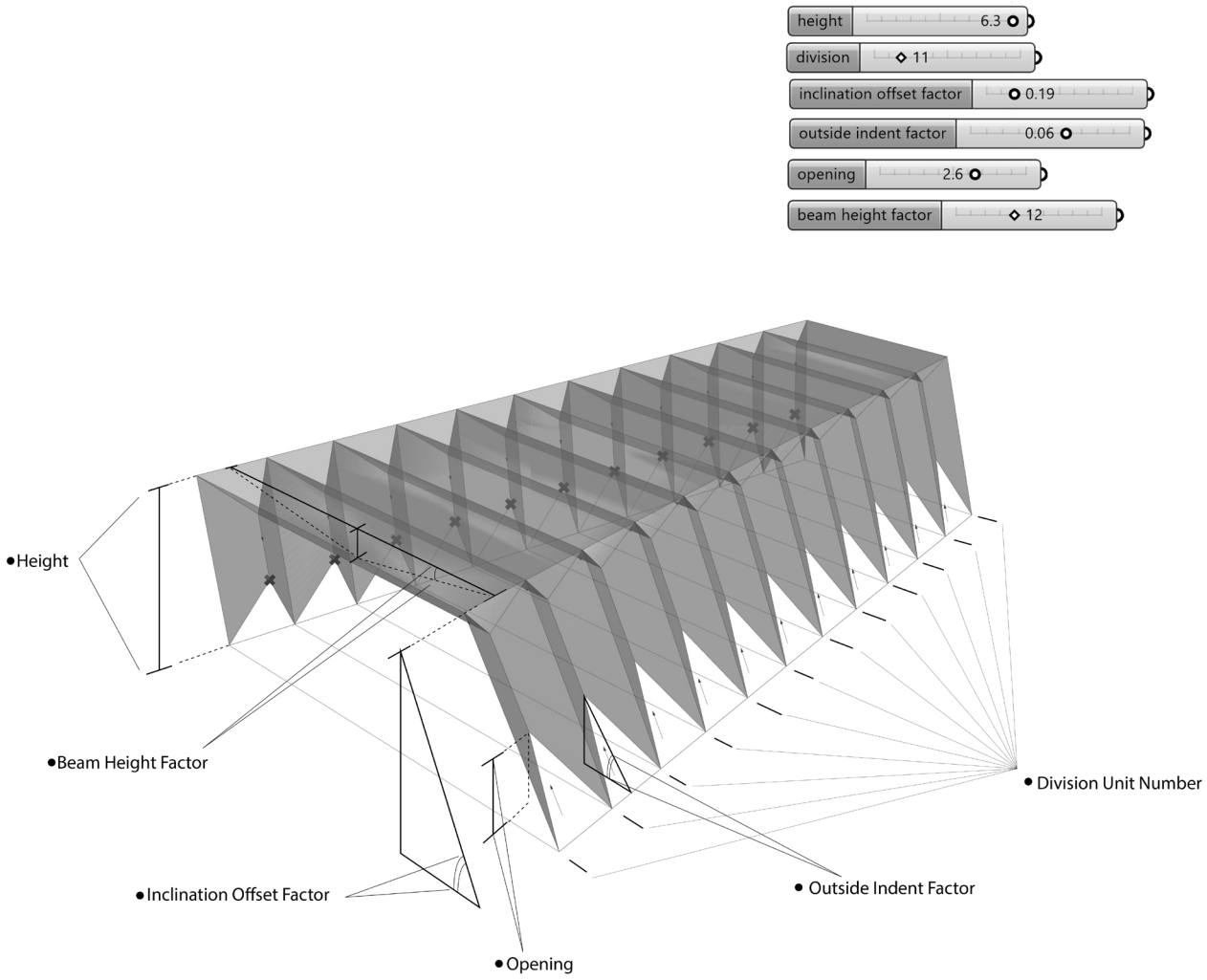
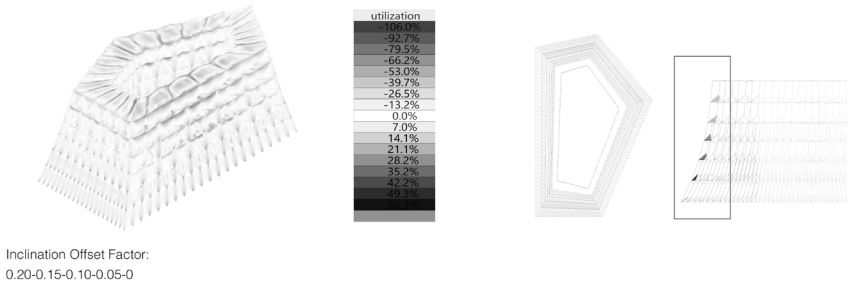


Fig: Principal Variable. Diagram. Elective Course Rethinking Timber System. Cornell AAP Fall 2018. Instructed by Katharina Kral.



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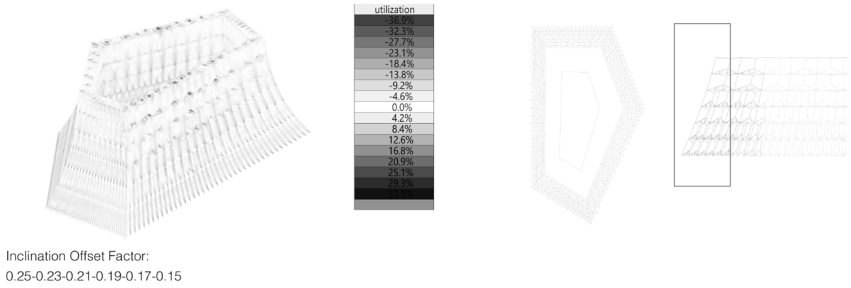

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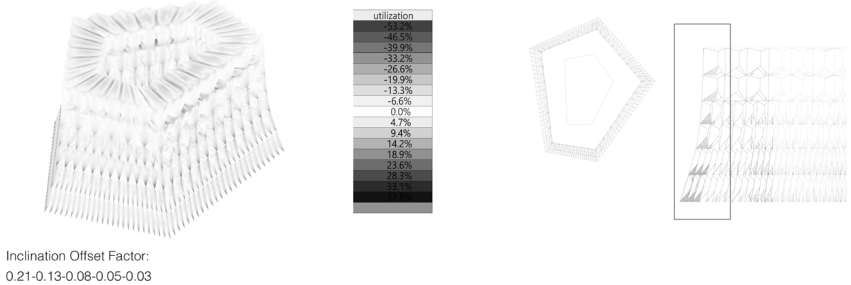

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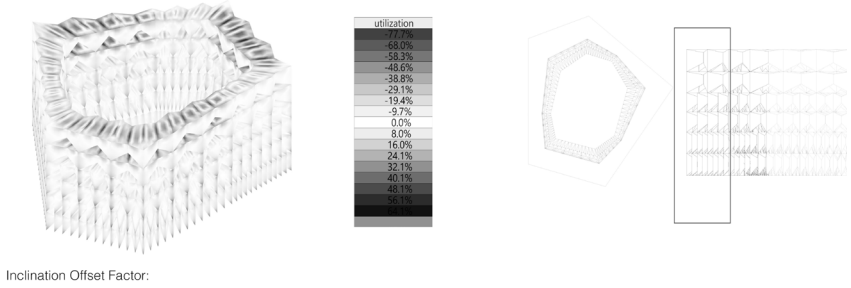

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Fig: Variation Diagram Showing Displacement Under Different Proposals. Elective Course Rethinking Timber System. Cornell AAP Fall 2018. Instructed by Katharina Kral.

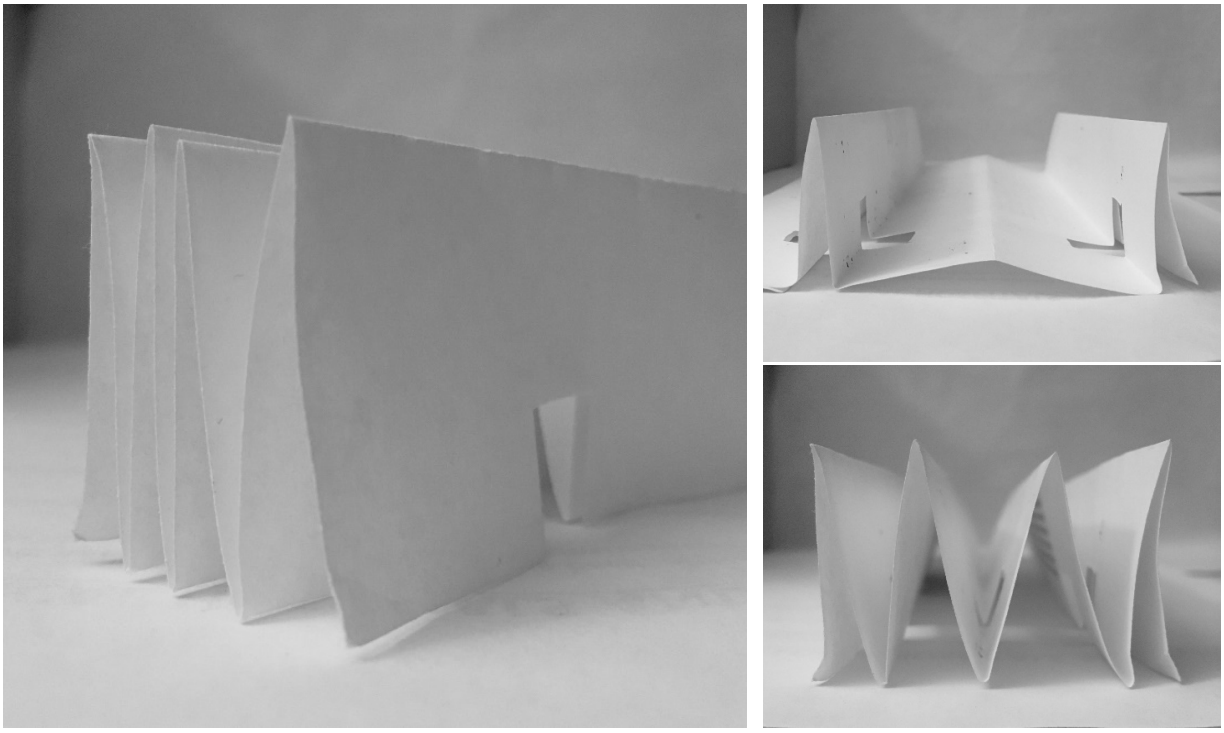
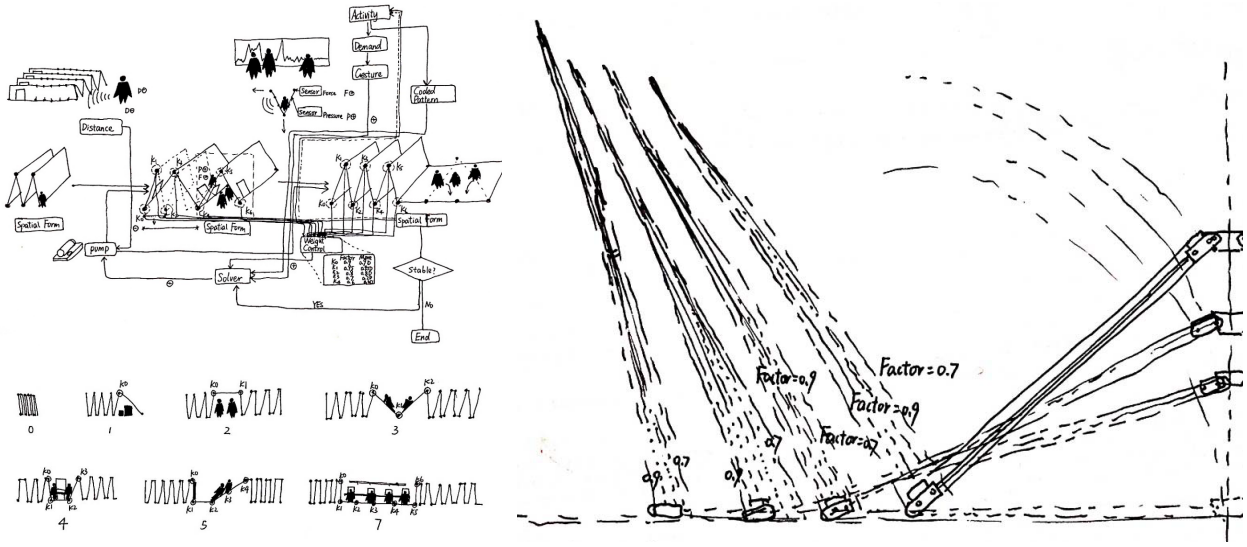


Fig: Proposal For Robotic Architecture. Design Research ARCH6301-Variable. Cornell AAP Summer 2018. Instructed by Axel Kilian.



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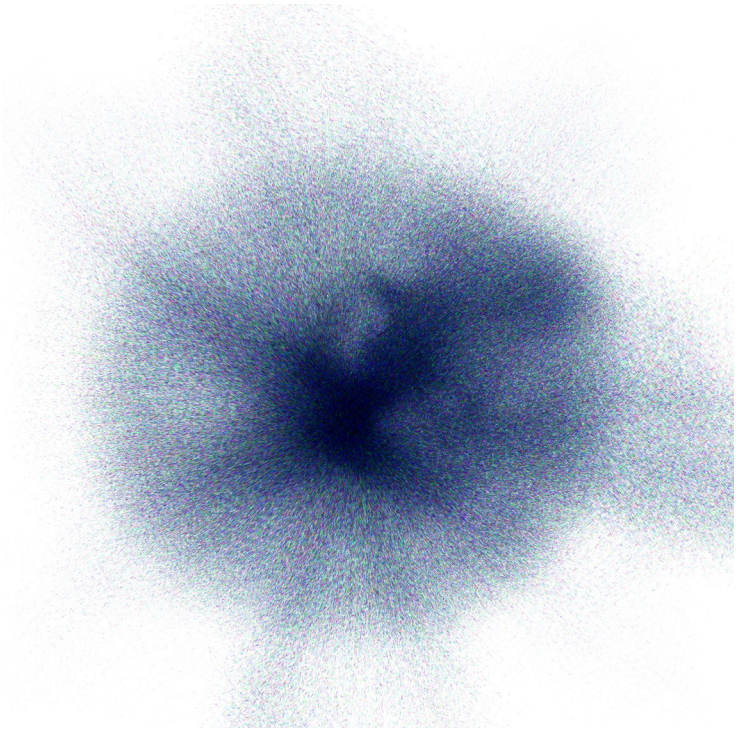


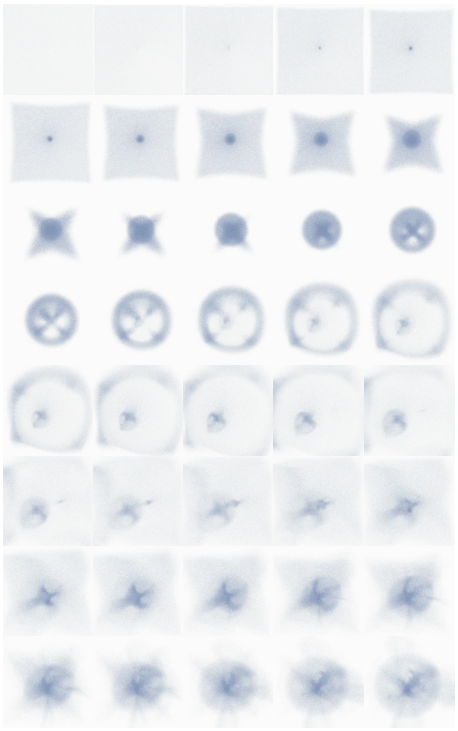


Fig: Processing Drawing. ARCH6110 Graduate Design Seminar. Cornell AAP Summer 2018. Instructed by Fleet Hower.

```
ArrayList<Particle> m;
int count = 400000;
float spdLimit = 550;
final static int SUNSET = 1;
final static int ICE = 2;
final static int FIRE = 3;
final static int THEME = ICE;
void setup() {
  size(3000, 3000);
  colorMode(HSB, 360, 100, 100);
  m = new ArrayList<Particle>();
  for (int i = 0; i<count; i++) {
    m.add(new Particle());
  }
  mouseX = width/2;
  mouseY = height/2;
}

void draw() {
  noStroke();
  fill(355);
  rect(0,0,width,height);
  for (Particle a : m) {
    a.update();
    a.display();
  }

  if(frameCount%5==0){
    saveFrame("####.jpg");
  }


class Particle {
  PVector prev, pos, mouse = new PVector(), spd, acc;
  color col;
  float turnFactor = random(10, 13);

  public Particle() {
    pos = new PVector(random(width), random(height));
    prev = new PVector(pos.x, pos.y);
    spd = new PVector(random(2), random(2));
    acc = new PVector();

    switch(THEME) {
      case SUNSET:
          col = color(random(320, 420) % 360, 90, 100,100);
          break;
      case ICE:
          col = color(random(80, 360), random(50, 100), 100,100);
          break;
      case FIRE:
          col = color(random(45), 90, 100,100);
          break;
      default:
          col = color(random(360), 90, 100,100);

          break;
    }

  }

  void update() {
    prev = new PVector(pos.x, pos.y);
    if (pos.x > width || pos.x < 0) {
      spd.x *= -0.9;
    }
    if (pos.y < 0 || pos.y > height ) {
      spd.y *= -0.9;
    }
    mouse.set(mouseX, mouseY);
    acc = mouse.copy().sub(pos);
    acc.normalize();
    acc.div(turnFactor);
    spd.add(acc);
    spd.limit(spdLimit);
    pos.add(spd);
  }

  void display() {

    //noStroke();
    //fill(col);
    //ellipse(pos.x, pos.y, 1, 1);
    //ellipse(pos.x, pos.y, 1, 1);
    stroke(col);
    strokeWeight(1);
    line(prev.x, prev.y, pos.x, pos.y);

  }
}
```

Fig: Script of Processing Drawing. ARCH6110 Graduate Design Seminar. Cornell AAP Summer 2018. Instructed by Fleet Hower.

In the "Anthropocene Style" Studio taught by Philippe Rahm, I systematically study the carbon dioxide emission issue and LCA methodology. Different from analyzing data from a purely computational point of view, I try to express an idea of slowness which is also crucial in nowadays carbon-driven design. Through systematically studying the superimposition of building program, the temporality occupation of different activities, the periodic building process and limited construction is proposed as a way to redeem the carbon emission relating to a specific phase. Thus the idea of reducing carbon emission was translated and represented in minimalism like manner of architecture.

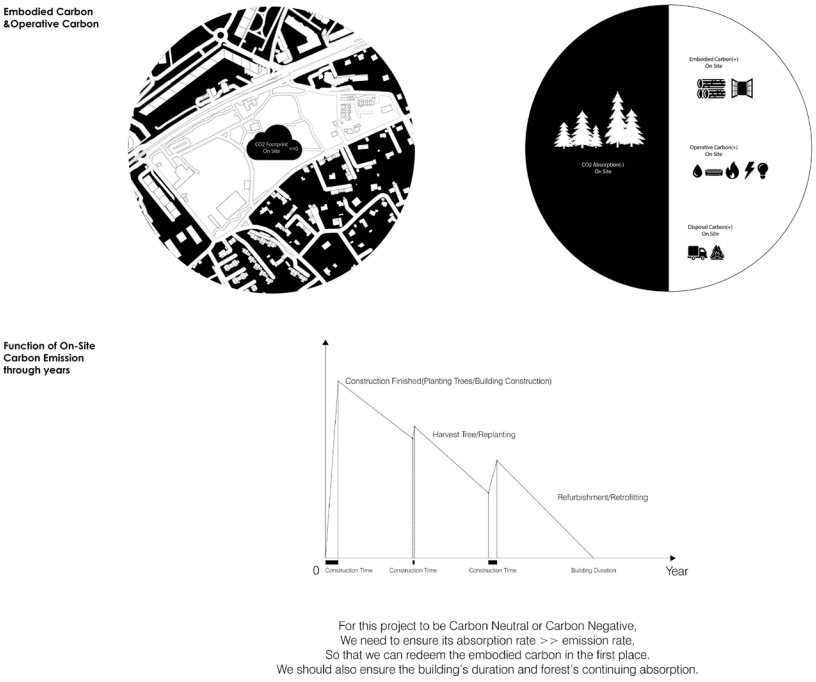
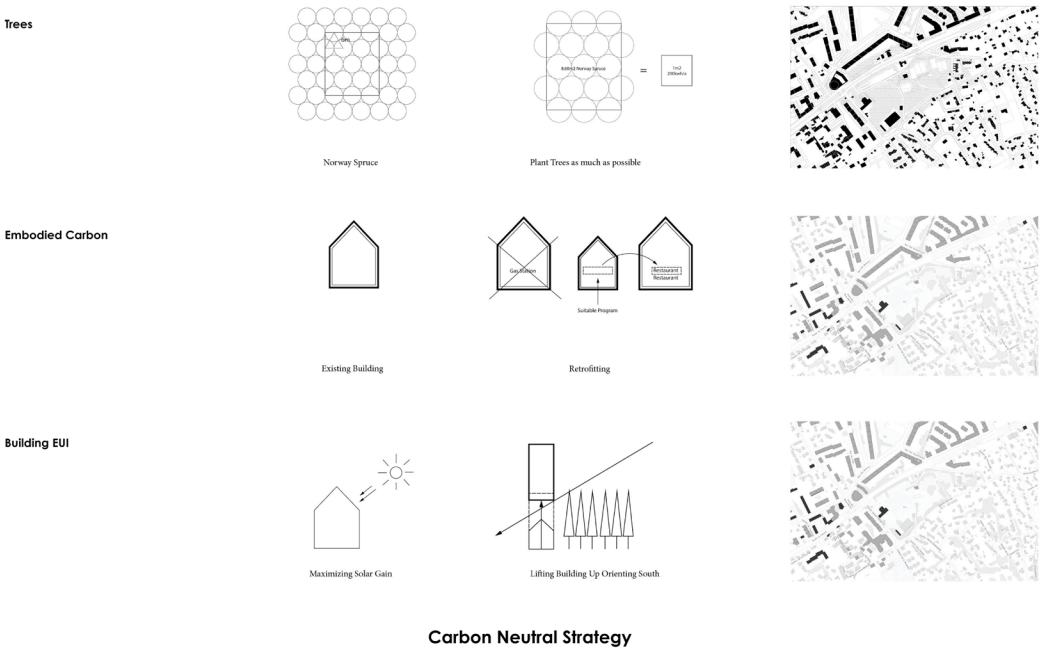
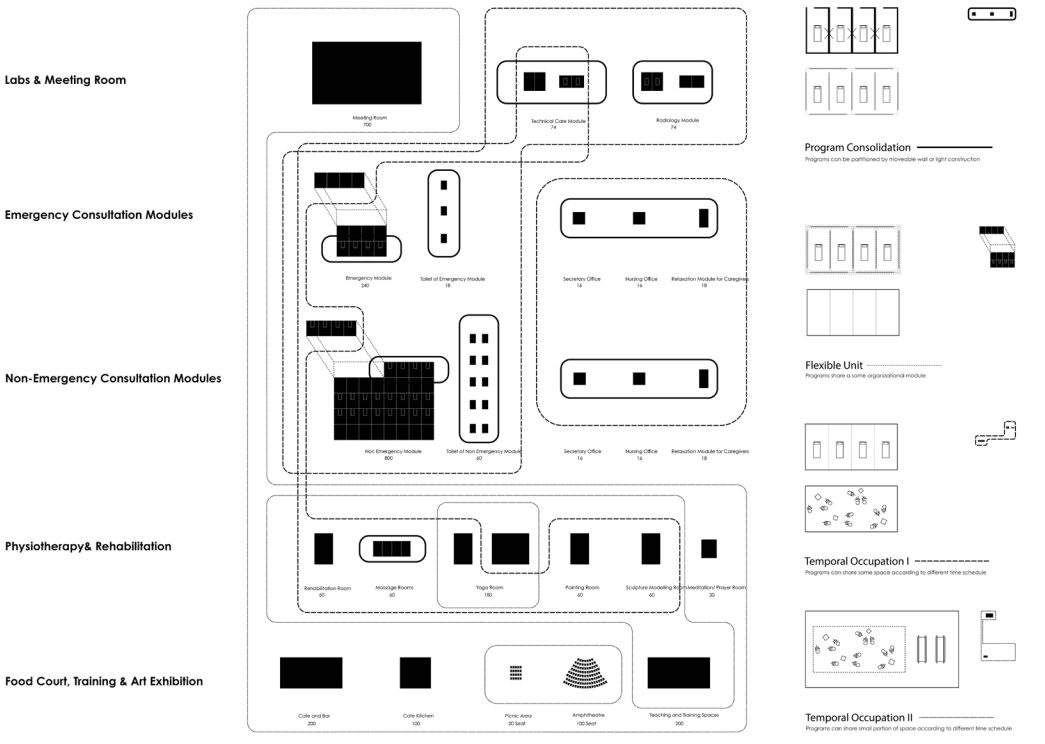


Fig: Estimate Graph of Carbon Emission on Site Showing Carbon Redemption. Option Studio Anthropocene Style. Cornell AAP Spring 2019. Instructed by Sarosh Anklesaria and Philippe Rahm.



Carbon Neutral Strategy



Program Overlay Diagram

Fig: Diagram of Carbon Zero Strategies and Program Superimposition. Option Studio Anthropocene Style. Cornell AAP Spring 2019. Instructed by Sarosh Anklesaria and Philippe Rahm.

Year Scheme Diagram

Fig: Consecutive Year Scheme. Option Studio Anthropocene Style. Cornell AAP Spring 2019. Instructed by Sarosh Anklesaria and Philippe Rahm.

Fig: Plan of Final Year and Plan Superimposition. Option Studio Anthropocene Style. Cornell AAP Spring 2019. Instructed by Sarosh Anklesaria and Philippe Rahm.

Fig: Rendering of Construction in Each Phase. Option Studio Anthropocene Style. Cornell AAP Spring 2019. Instructed by Sarosh Anklesaria and Philippe Rahm.

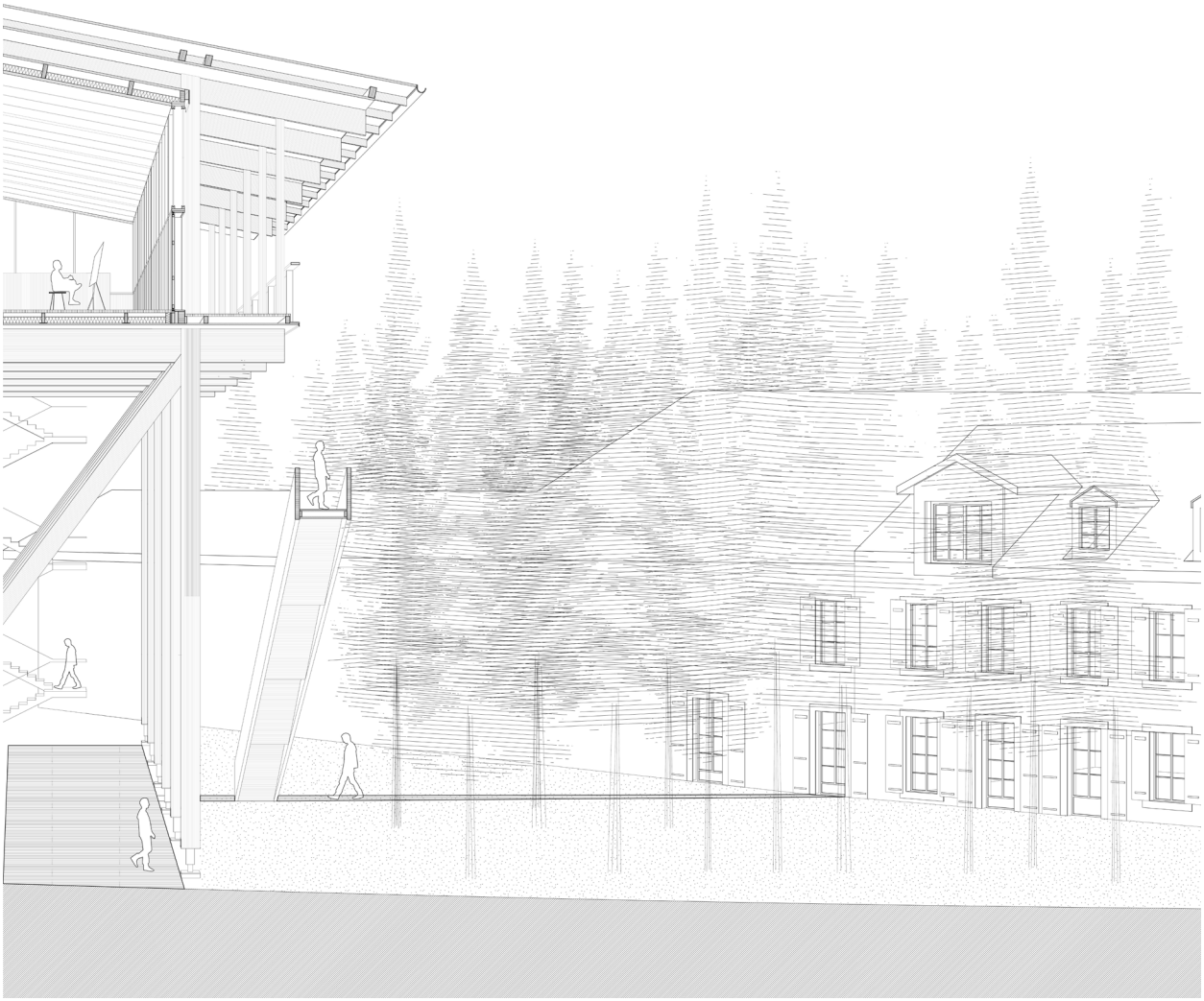


Fig: Sectional Perspective of Restaurant Annex in Year 10. Option Studio Anthropocene Style. Cornell AAP Spring 2019. Instructed by Sarosh Anklesaria and Philippe Rahm.

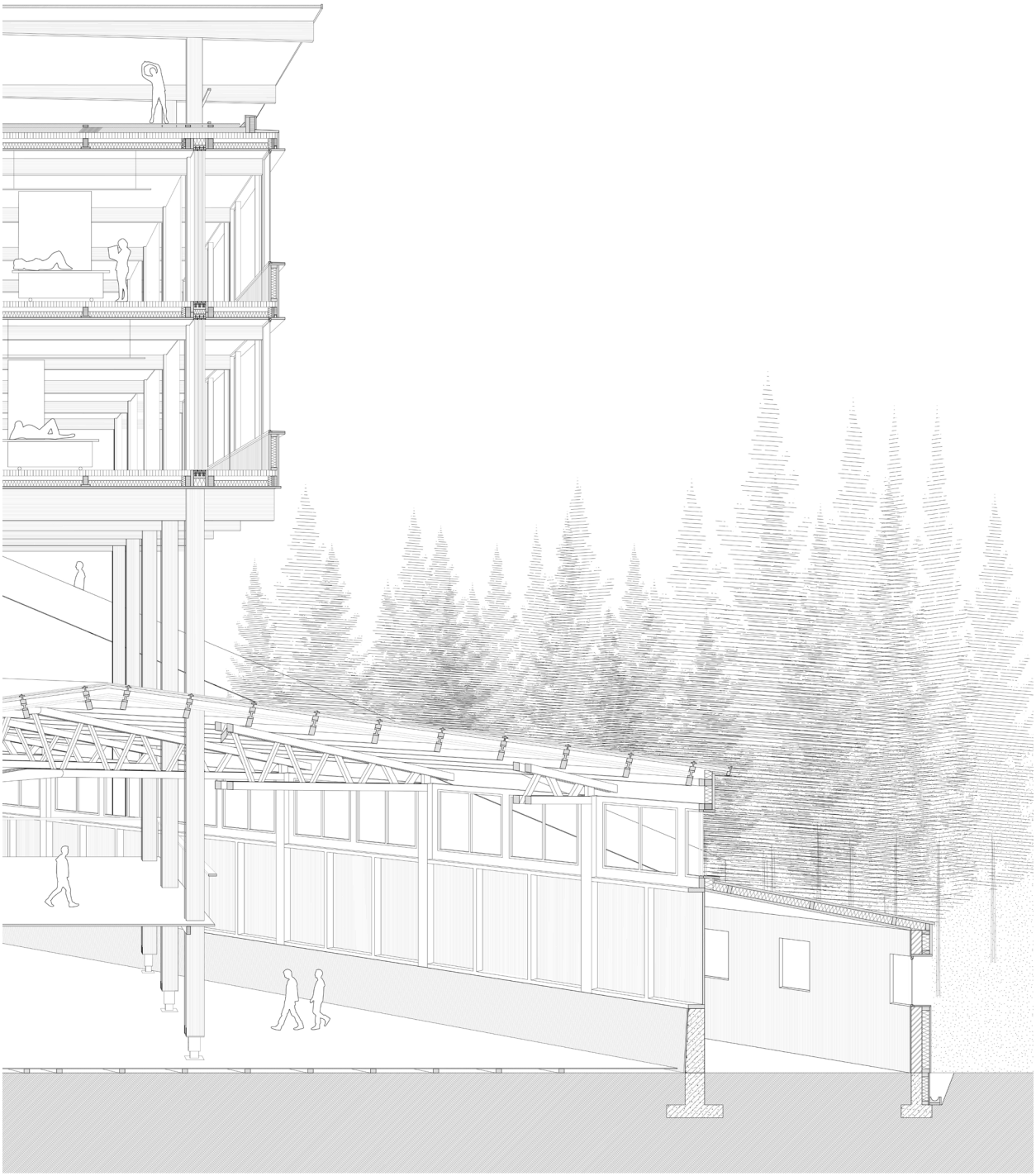


Fig: Sectional Perspective of Horse Riding School Annex in Year 3. Option Studio Anthropocene Style. Cornell AAP Spring 2019. Instructed by Sarosh Anklesaria and Philippe Rahm.

Conclusion

Throughout history, the structure underneath the appearance of architecture is always dedicated to the representation of reality, a manifestation of a certain idea, a consolidation of specific data and an embodiment of energy. It is articulated through plans, sections, and perspectives. It is executed through programs, software, and platforms. Either way, it needs to be drawn, scripted and represented in order to be the imprint of the era.

To draw is to represent, however, to represent is not to draw randomly. Representation needs to have a specific depth of systematically thinking. It is inherently coherent, richly layered and carefully fabricated. Like language, it is a manner of conveying and communicating. In order to be the representation, drawing needs to be structuralized. In order to be Architecture, "plans" need to be structuralized.

Bibliography

Hersey, George L. The Lost Meaning of Classical Architecture: Speculations on Ornament from Vitruvius to Venturi. Cambridge, Mass.: MIT Press, 1988.

Rossi, Aldo, and Peter Eisenman. The Architecture of the City. Cambridge, Mass.: MIT Press, 1982.

Rossi, Aldo. A Scientific Autobiography. Cambridge, Mass.: MIT Press, 1981.

Evans, Robin. The Projective Cast: Architecture and Its Three Geometries. Reprint. Cambridge: MIT Press, 2000.

Office for Metropolitan Architecture. Small, Medium, Large, Extra-Large: Office for Metropolitan Architecture, Rem Koolhaas, and Bruce Mau. Edited by Rem. Koolhaas, Bruce. Mau, Jennifer. Sigler, and Hans. Werlemann. 2D ed. New York, N.Y.: Monacelli Press, 1998.

École polytechnique fédérale de Lausanne. A-Typical Plan: Projects and Essays on Identity, Flexibility and Atmosphere in the Office Building. Edited by Jeannette. Kuo, Atelier. Kuo, and Iñaki Abalos. Zurich: Park Books, 2013.

Carpo, Mario. The Second Digital Turn: Design beyond Intelligence. Cambridge, Massachusetts: The MIT Press, 2017.