P5 Reflection

Lincheng Jiang
4801334

By building an overall algorithm framework, and then researching and solving toy problems, I managed to establish a set of methods and generated a floor plan considering the potential of daylight hours and circulation efficiency.

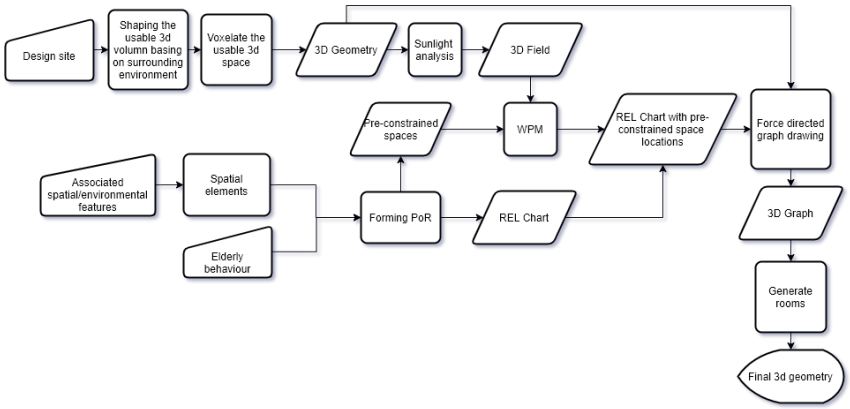

Figure 1 Previous design methodology in the graduation plan

Compared with the approach envisaged in the initial graduation plan, my current method has been improved a lot. At the beginning, my argumentation was not clear enough due to my lack of understanding of the topic I want to study, and the method I initially envisioned lacked sufficient knowledge of specific methods, tools, and knowledge, which resulted in the selection of unrealistic methods and approaches. Pirouz and Regina helped me to specify my goals through feed backs and provided me with directions for reading and further research. After many feedbacks from them, I accumulate the knowledge base needed to study the subject, and at the same time re-examine and adjusted my argumentation and methodology to make the two more practical.

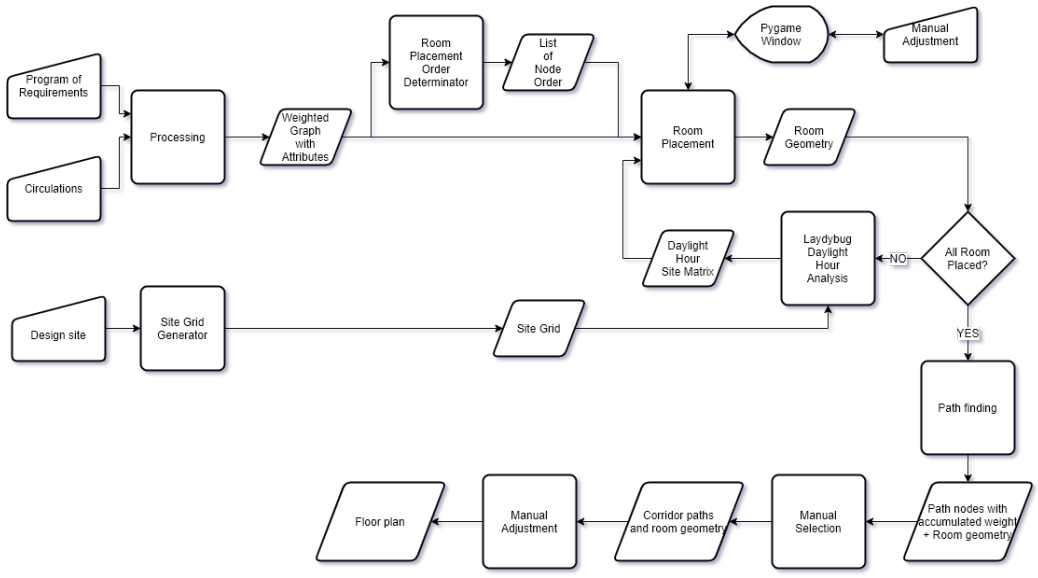

Figure 2 Current design methodology

The work during this graduation has taught me so much on how to clarify goals, build up research frameworks, break down problems and approach the answers step by step.

In this graduation topic, my research is realized through solving series of toy design problems. Which is small and simple yet representative of the more sophisticated problem (Nourian, 2019). Then improve the method with the feedback from the process of solving toy problems and apply the method to design a nursing home. The research process provides the design a framework. Then the realization process of the design problem feeds back to the research and helps improve research contents.

This topic is within the scope of the studio topic Computational Layout Optimization. Within the track of Building Technology. It is part of the research framework of Chair Design Informatics. This graduation project seeks using computational method to bridge between architecture design and computer science. It provides designers a tool to generate practical floor plans regarding circulations and daylight hour potentials of the floor plan through their workflow of design.

In the final research, I chose to start with the characteristics of the design requirements. The daylight hour potential of rooms is strongly related to the relative position of the room, while the circulation efficiency is strongly related to the direction of the corridor and the position of the door opening in the room.

Therefore, I divided the research topic into two parts, using the force directed method of the pymunk physics engine to solve the problem of room location, and solving the problem of corridor direction and door opening location through path finding algorithm and genetic algorithm. Because daylight hour potential is strongly related to the location of the room, daily analysis is embedded in the process of generating the room location through the physics engine.

The methodology designed is to first generate a weighted graph that includes all rooms and circulations by processing the circulation in the building, the attributes of each room and the requirements for daylight.

Then, through a series of judgments to generate the order of placing the rooms, first judge the summed weight of the edges connected to each node, then judge which node has the least degree (higher average weight), and then judge which room has the largest size.

Then place the rooms in order and use spring to connect the rooms with physics engine.

When all the rooms are placed, analyse the daylight hour in the order of placement. When one room is analysed, the room is set as static body, and the rest of the rooms are squeezed out of the range that does not meet the daylight hour requirements, and then the next room and all rooms that have become static bodies are analysed for daylight hour together until all rooms are placed.

In each process of placing the room, the designer can use the mouse to drag the position of the room to adjust the relative relationship between them.

When all the rooms have completed the daylight hour analysis and fixed their positions, according to the weights of different circulations, the path finding algorithm is used to find the nodes of all possible paths that connects each room.

Finally, designers determine the final paths to create corridors, manually adjust the room shapes and positions, turn the result into a floor plan.

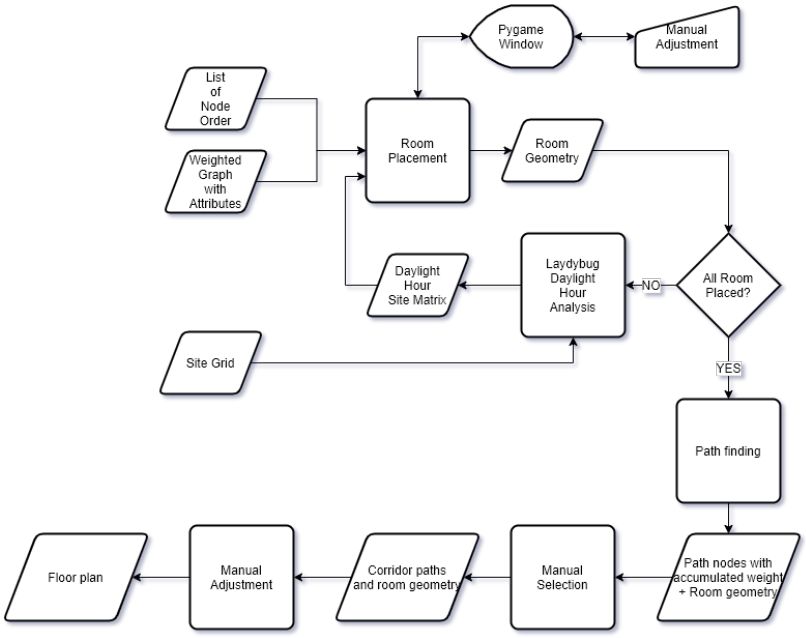

Figure 3 General relation between room placement component, Ladybug daylight hour analysis component and path finding component.

This set of methodology proposes a feasible way to realize the circulation based on daylight hour analysis and room relationship and the shortest path circulation optimization method at the same time in one consistent workflow, and the designer can intuitively intervene in the computer design process, intuitively affect the final result.

The aim of this graduation studio has been to propose a systematic way of configuring buildings to optimally meet functional requirements given a program of requirements, accessibility, and daylight requirements and complex site constraints. Through my research and design on multiple toy problems. I have been able to embed daylight hour potential analysis into the process of layout generation.

Chinese society is aging fast. Needs for elderly welfare infrastructures and facilities are rising. Nursing homes as important components of elderly welfare require complex decision making during the design process. It serves as a humanity infrastructure which requires for liveability, in this thesis, daylight hour is discussed, yet also provides serves that ask for circulation efficiency.

This graduation work would help architects better optimize spatial plans of buildings under these two requirements, which potentially improves the future built environment for elderlies. It can also work as a framework for other design cases that requires the satisfaction of multiple criteria.

Because of the limitation of the study, some ethical issues and dilemmas might still happen:

(i) During the research:

While the thesis involves optimization theory, graph theory, force directed methods, computational geometry and daylight hour analysis in some way, the detailed discussion of each subject falls out of the scope of the project. So, the substitutional methods being used for specific purpose might be inaccurate.

For example, the reason that I define the daylight hour analysis as "daylight hour potential", is because the actual daylight hour analysis requires much more, including room size, window size, room solid boundaries, etc. Placing the room with window opening on all sides above the Ladybug daylight hour analysis matrix just neglects lots of things mentioned above. Because of the appearance of the roof of rooms, placing and analysing rooms from south of the map to the north helps regulating the result, but for rooms that are horizontally attached or close to each other, it is still inaccurate. Therefore, more detailed analysis needs to be done in the workflow of design after this. It cannot be seen as a final answer.

(ii) During toy problem solving and the design of nursing home:

The current method workflow is from 'room placement with spring connection' to 'daylight hour analysis' to 'shortest path generation'. Step 'room placement with spring connection' gives a rather weak shortest-path-directed result, then 'daylight hour analysis' gives a strong daylight-hour-directed result, then 'shortest path generation' gives a strong shortest-path-directed result. This is due to the characteristic of nursing home, which not only focuses efficiency, but also the living environment of its residents, and the consideration of for the living experience of its residents, efficiency can be sacrificed to a certain level. If the vision of the designer is strongly shortest-path-directed or the design is strongly efficiency oriented, this pre-set hierarchy will not meet the need. Designer should reach for other tools.

(iii) Potential applications of the results in practice

Due to technology/algorithm encapsulation, or knowledge barriers, although it can be informed to a certain extent through the documentation, it may still encounter various unexpected problems in actual use. Some problems are obvious mistakes and are easy to be found, and some problems are beyond the scope of expectation, and the results seem to be correct, then this kind of problem is difficult for users without corresponding knowledge to detect. If the results with such problems are adopted as part of the design, it may lead to potential risks and inequality.

Therefore, before further publicizing the specific program for designers to try, it is necessary to find and solve the problem through series of trials and errors through toy problems. At the same time, when passing knowledge about this algorithm/program, the distortion that happens in the process of information dissemination, or the misunderstanding of specific nouns or narrative methods, may

make different user have different understanding on certain commitment of the algorithm/program, and the results produced from it.

By providing example files and instructions, or with the design of the specific process of using this algorithm/program, can provide users a certain extent of knowledge relates to it.