

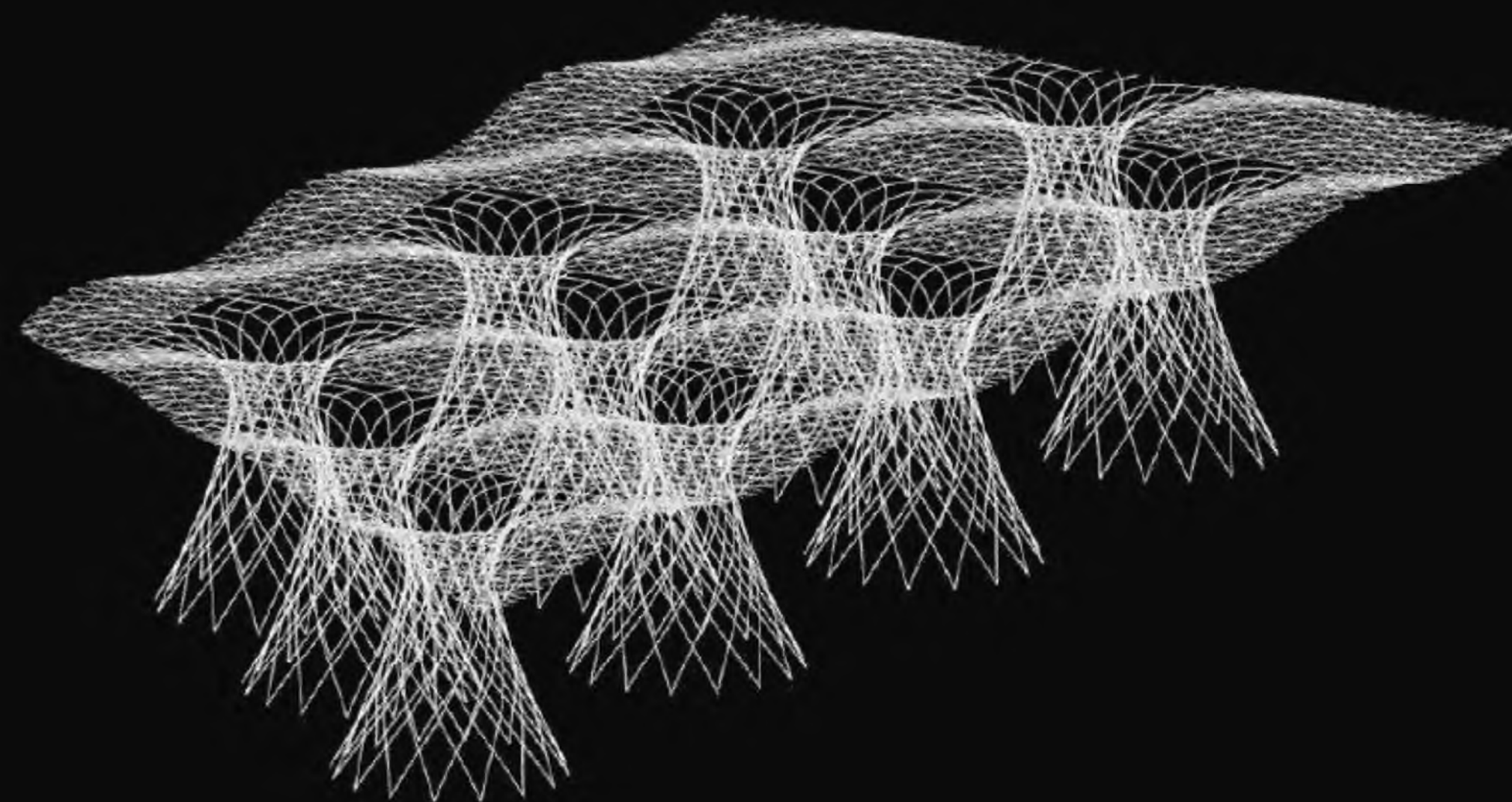
Внедрение методов генеративного проектирования в архитектуру

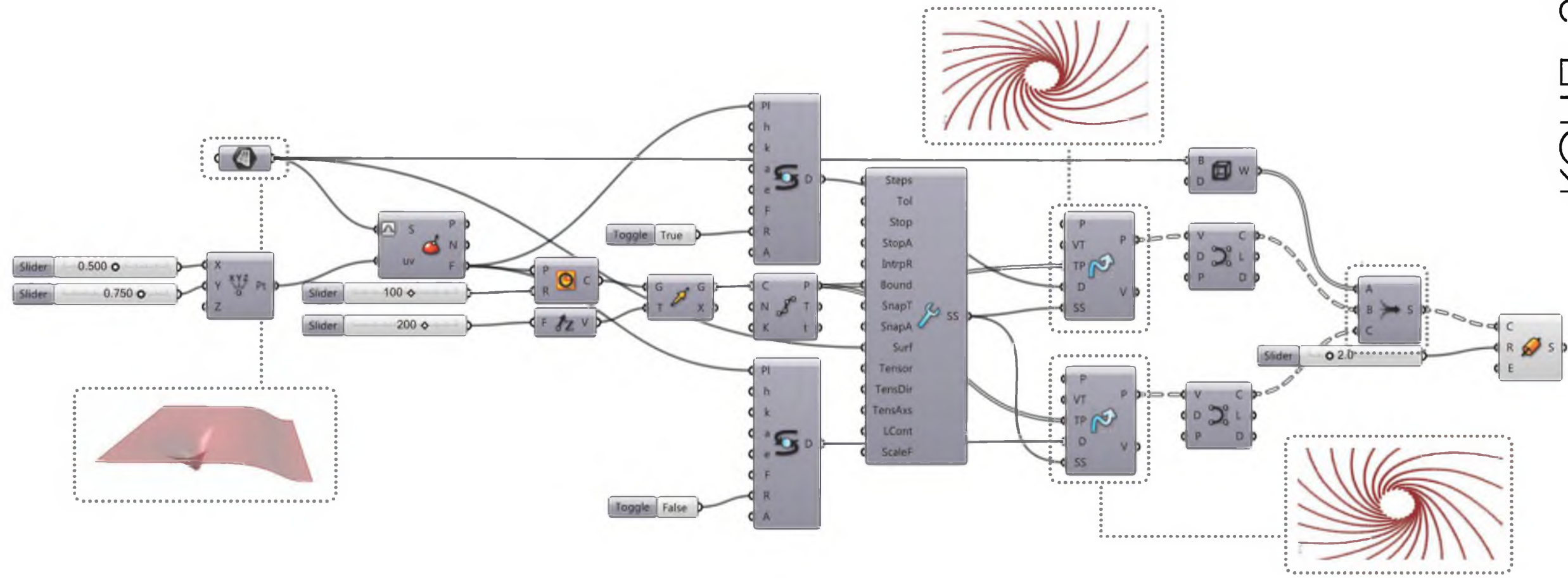
КСНП-2020

Выступление подготовил:
Толкачев А.О., ст. 210 гр.

В настоящее время в проектных решениях крупных общественных зданий не применяются методики генеративного проектирования в связи с отсутствием алгоритмической системы для данного типа зданий.

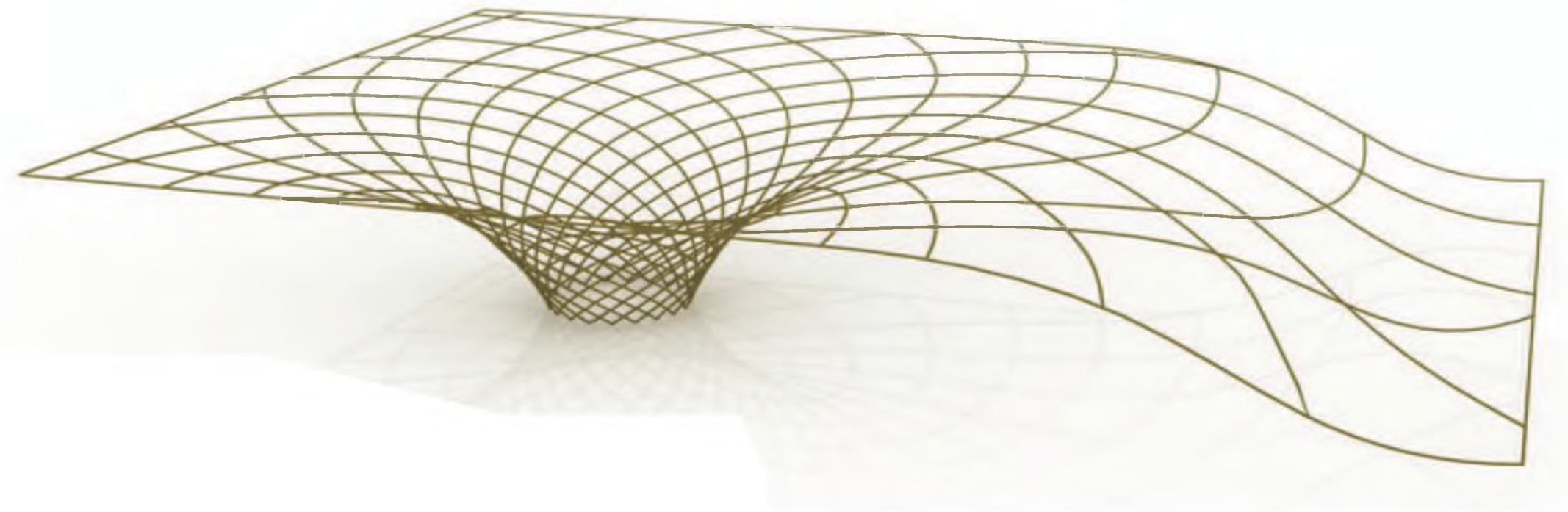
На данный момент алгоритмические системы разрабатываются для малоэтажных жилых зданий, а также малых архитектурных форм и градостроительства.





Одна из новых тенденций в архитектуре и дизайне – это использование такого инструмента как вычислительные методы для проектирования, заключающихся в создании определенных алгоритмов и скриптов, которые создают архитектурные формы.

Вычислительным является не дизайн или архитектура, а подход к проектированию, принципиально отличный от общепринятого: вместо выполнения задачи одним из доступных инструментов, вы сами создаете эти инструменты, исходя из поставленной задачи.





Весь процесс архитектурного проектирования можно охарактеризовать работой с теми или иными данными и разделить на три этапа:

1

анализ
исходных данных;

2

создание решения
на основе данных;

3

получение итоговых
данных для реализации.

BIM

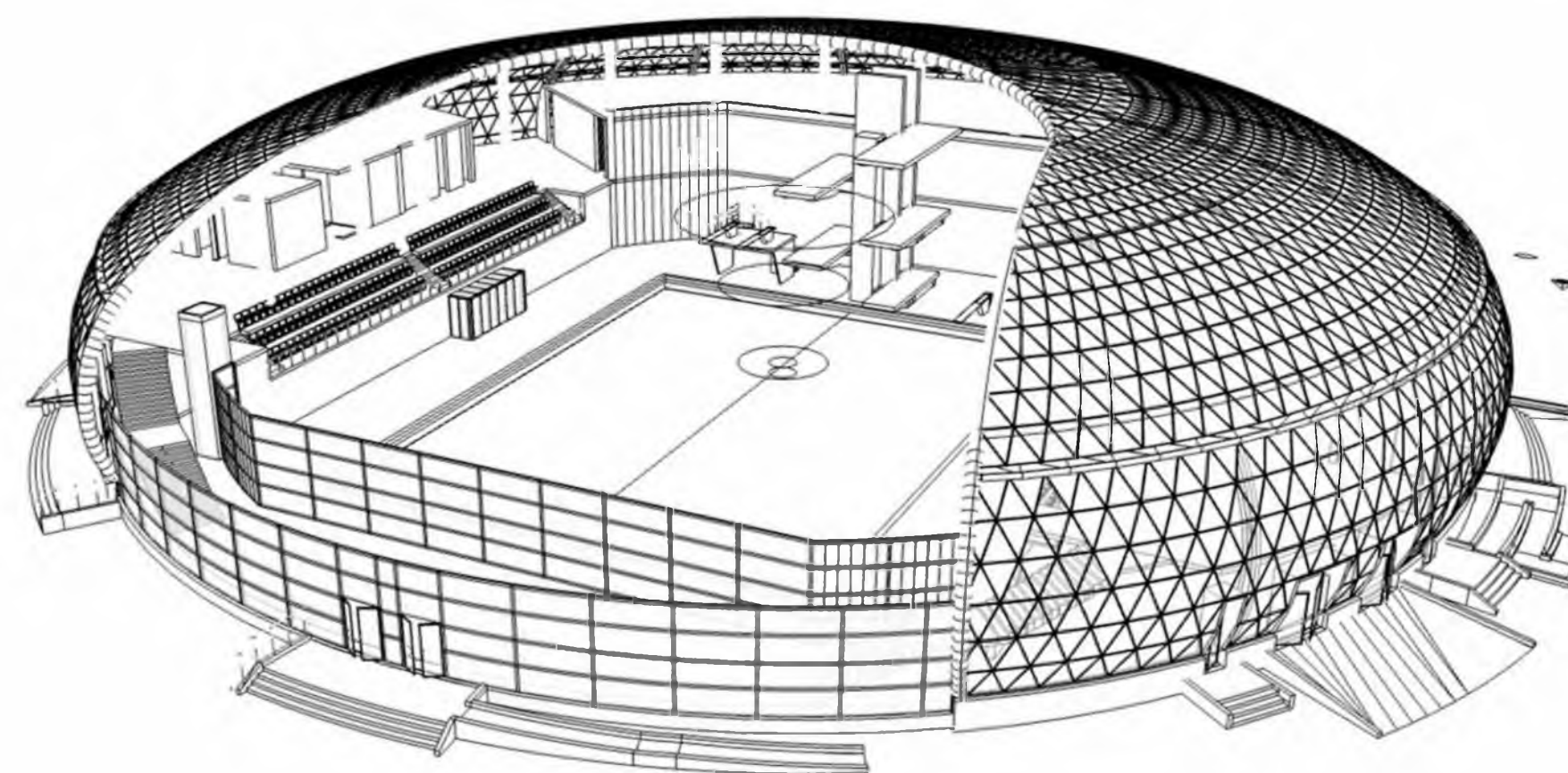
Building Information Modeling

BIM

Информационная модель зданий и сооружений, под которыми в широком смысле понимают любые объекты инфраструктуры

Казалось бы, вся эта модель проектирования уже имеет отражение в таком понятии как Информационное моделирование зданий или сокращенно BIM (от принятого в английском языке термина Building Information Modeling).

Но в данной системе имеется один недостаток – вся эта система работает в ручном режиме управления человеком и на весь процесс проектирования накладывается тот самый коэффициент влияния человека, о котором говорилось выше.



Цели данной разработки:

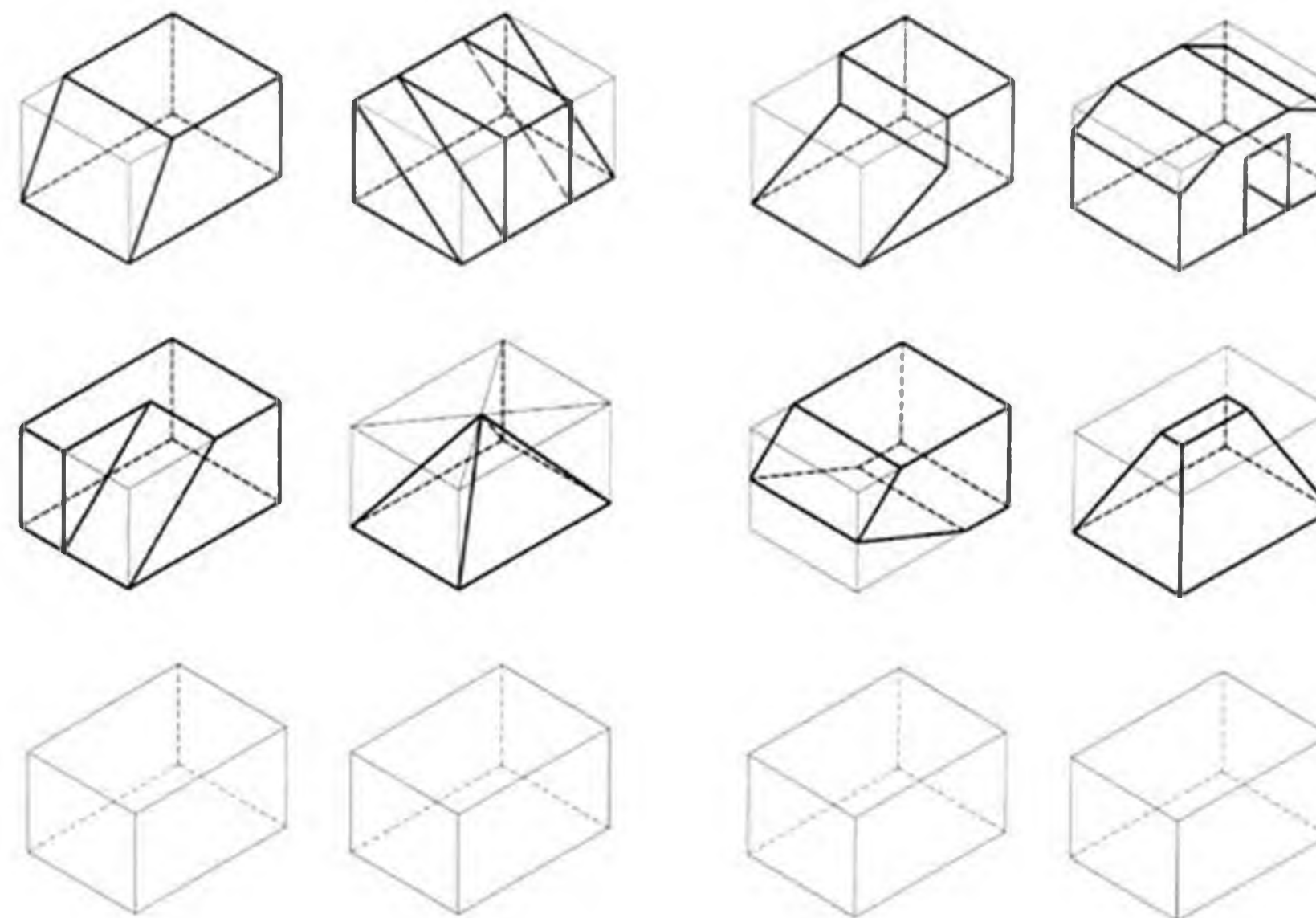
1 радикально сократить
время проектирования;

2 оптимизировать процесс
проектирования;

3 определить наиболее
релевантное проектное
решение.

Создание такой модели позволит отразить список необходимых стройматериалов и сформировать сметную стоимость на данный момент времени.

Варьируя требуемые параметры для данной генеративной модели, такие как площадь и основной материал стен, можно предоставить конечному покупателю различные ценовые предложения, которые сформируются в реальном времени.



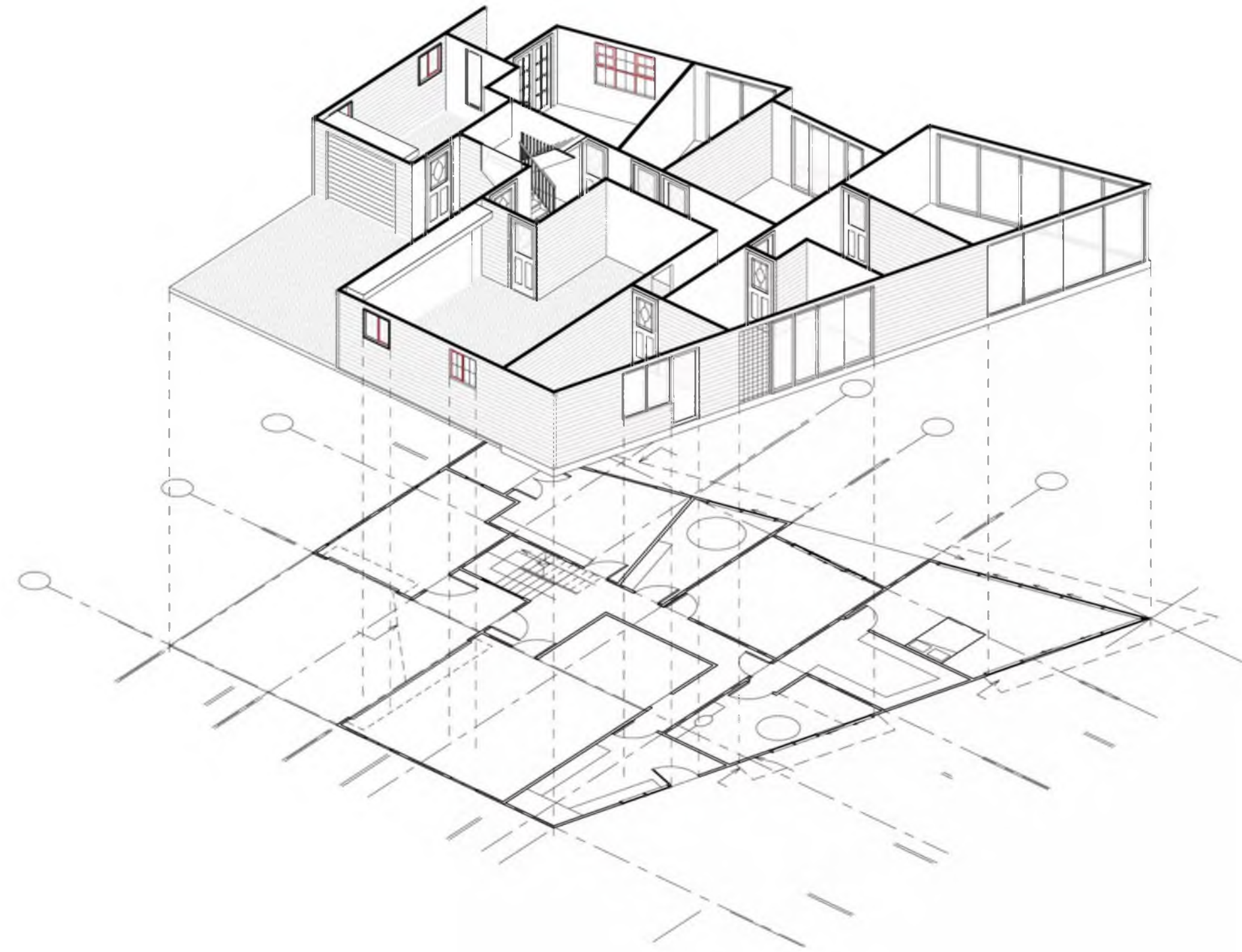
Основные задачи данной разработки

- 1** разработка генеративной системы для малых архитектурных форм;
- 2** разработка генеративной системы для малоэтажных жилых зданий;
- 3** разработка генеративной системы для многоэтажных жилых зданий.



С недавних пор серьезно рассматривается внедрение генеративного проектирования в проектных решениях малоэтажных жилых зданиях.

Об этом говорится в научно-исследовательской статье ФЕДЧУНА ДМИТРИЯ ОЛЕГОВИЧА – аспиранта кафедры проектирования архитектурной среды и интерьера Инженерной школы г. Владивостока.





« Модульные системы, компьютерное проектирование, параметрическая архитектура и искусственный интеллект – четыре этапа развития, которые, помимо исторического контекста, являются каркасом для радикального улучшения архитектурной концепции. Все вышеперечисленные этапы не являются независимыми друг от друга. В каждом последующем периоде наблюдается преемственность от предыдущего. ИИ можно выделить как кульминационную точку в эволюции архитектурной концепции ».

ФЕДЧУН ДМИТРИЙ ОЛЕГОВИЧ

аспирант кафедры проектирования
архитектурной среды и интерьера
Инженерной школы г. Владивостока.



Объекты, созданные с помощью генеративного дизайна, могут вызывать впечатление, что что-то подобное уже существовало.

НЕ СОВСЕМ



Генеративный дизайн – это технологии проектирования с использованием алгоритмов, когда система самостоятельно создаёт тысячи моделей, сравнивает их между собой и отбирает самые хорошо оптимизированные модификации.

При таком подходе инженер не занимается моделированием и оценкой первоначальных вариантов – это соревнование было бы неизбежно проиграно машине, поскольку искусственный интеллект выдает проектные решения, не принимая во внимание такие факторы как неопределенность, сомнения и основываясь исключительно на заданных параметрах.

GENERATIVE



Задачи человека в генеративном проектировании

BIM

- 1** Постановка задачи по проектированию архитектурного объекта;
- 2** Определение параметров, которым должны соответствовать генерируемые решения;
- 3** Отбор вариантов, соответствующих запросам заказчика.

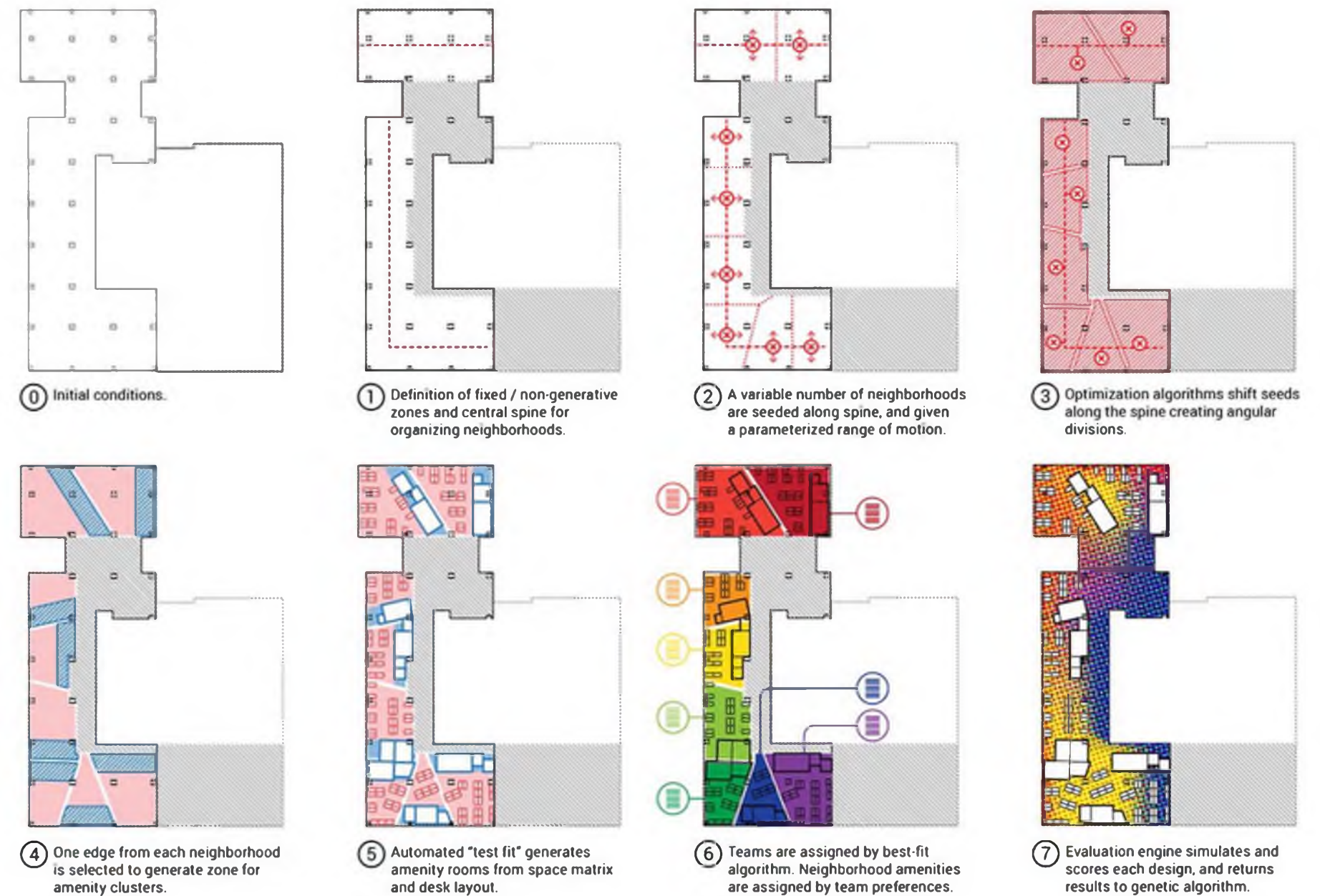


Постановка задачи

Использование эволюционных алгоритмов даёт отчасти случайный (в том смысле, что он не может быть до конца предсказан) результат, но всё же требуется базовая конкретизация задачи.

» Определение параметров

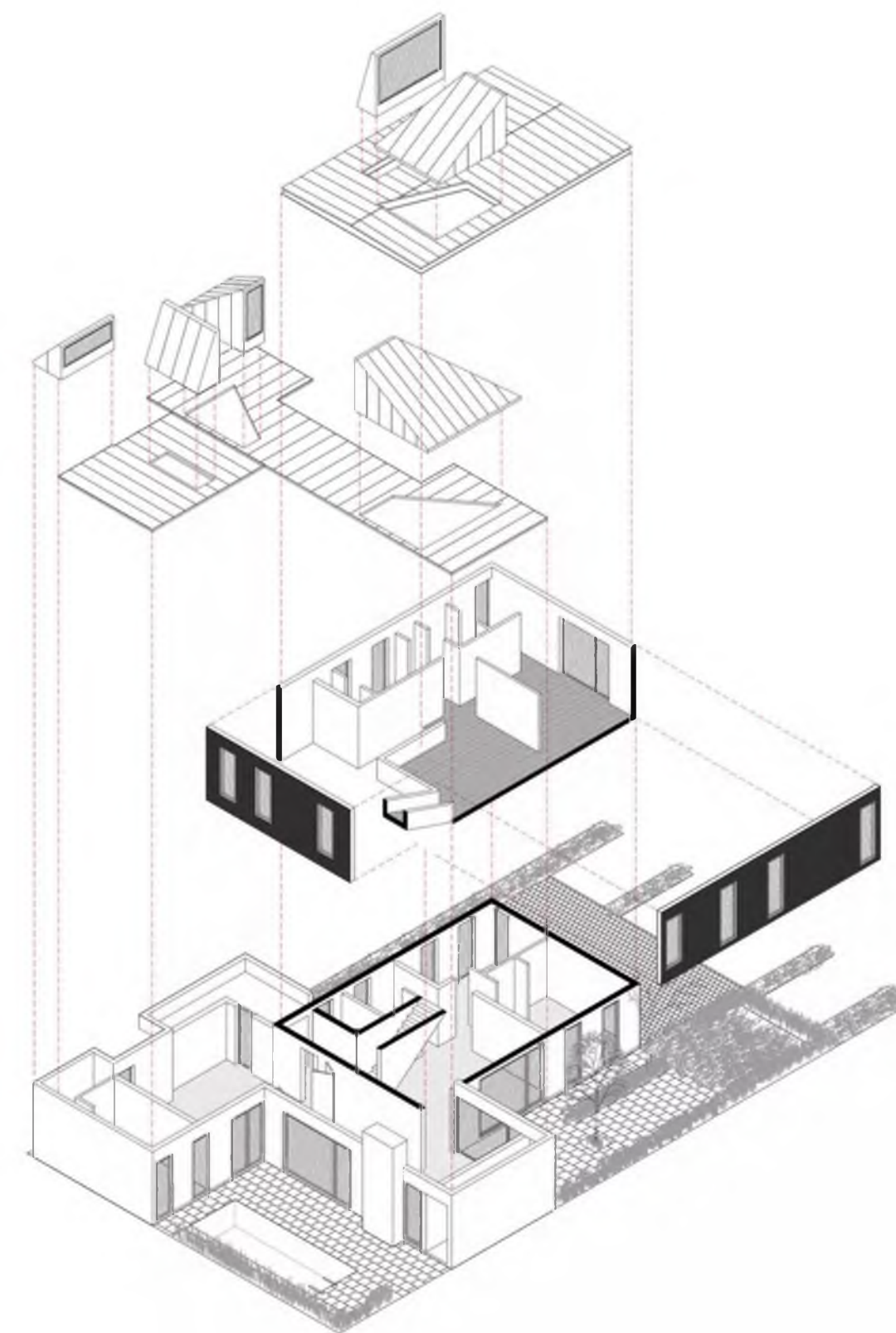
Пользователь определяет, каким характеристикам должны соответствовать генерируемые решения. Состав базовых параметров может включать показания состава грунта, данные инсоляции, сейсмические и климатические данные местности.





Отбор лучших вариантов

Система предлагает некоторое количество решений, которые отличаются по целевым характеристикам и все удовлетворяют поставленным условиям, дальше нужно выбрать соответствующий запросу заказчика вариант, то есть опереться на трудно поддающиеся какому-то формальному описанию критерии. С этим человек пока справляется лучше компьютера, поскольку он способен в большой мере раскрыть семантический аспект по сравнению с компьютером. Однако, здесь здание генерирует само себя. Когда появляется новая функция, здание саморегулируется.



Применение методов генеративного проектирования в разработке планировочного решения

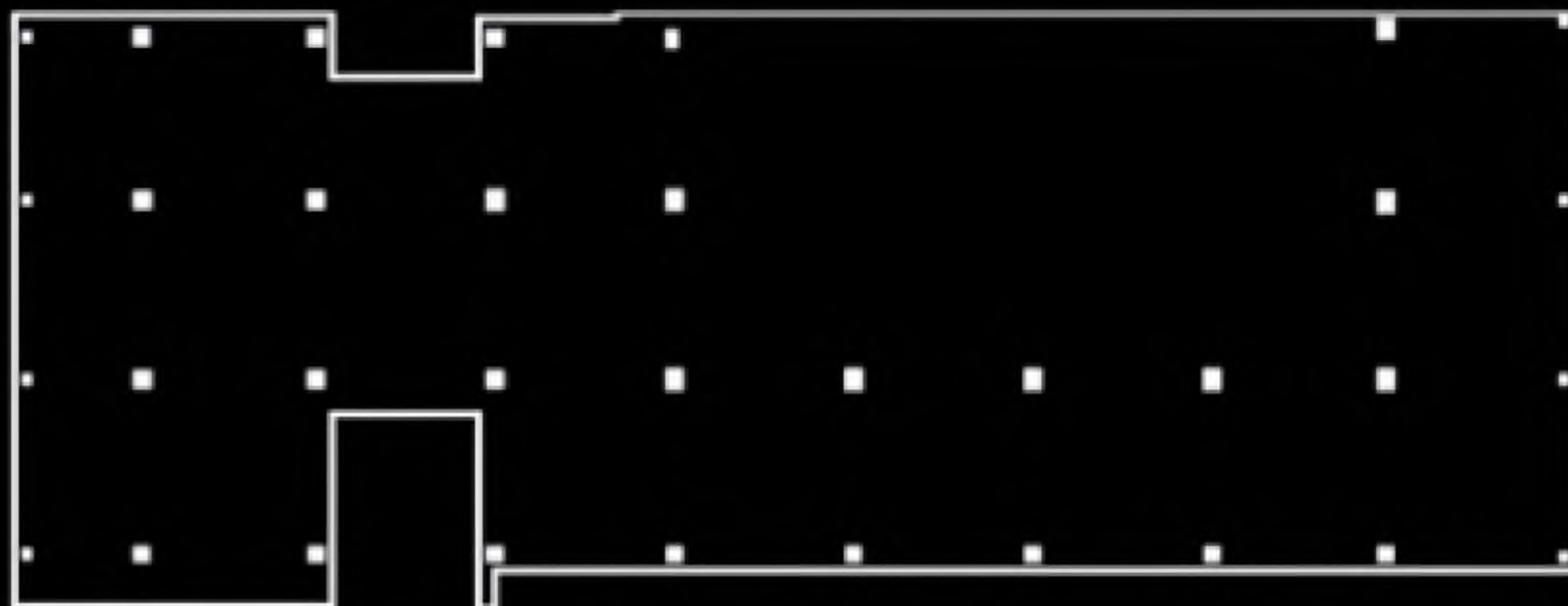
Разработка планировочного решения
для офиса Autodesk в Торонто
компанией Autodesk



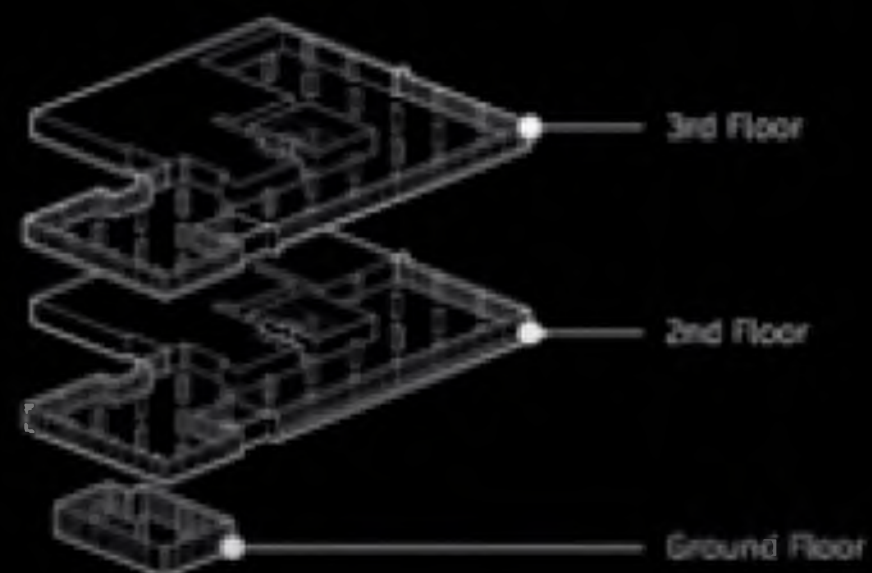
Данный слайд показывает, что изначально архитектор определяет границы проектного решения.

Уже имеется внешний контур, определен конструктив и тип здания.

GENERATIVE DESIGN
FOR ARCHITECTURE



For the design of a new Autodesk office space in Toronto, we started with the **constraints of three floors** in a new building...

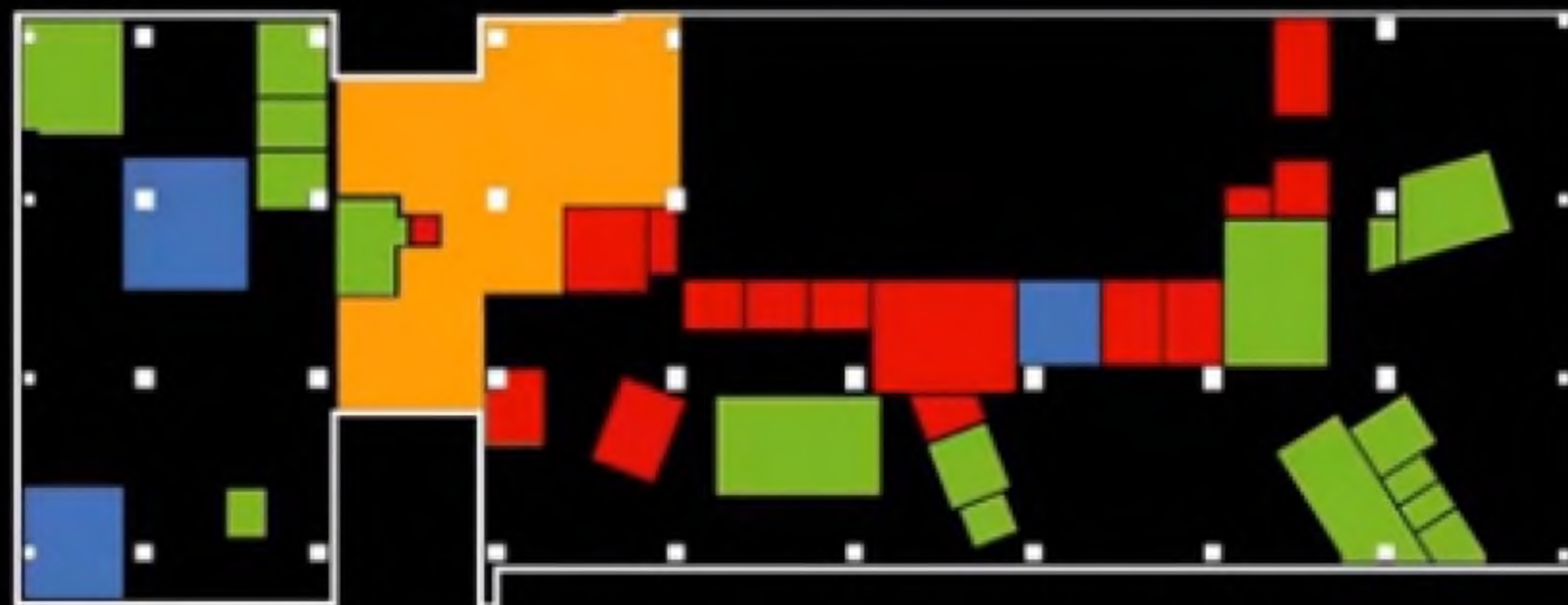




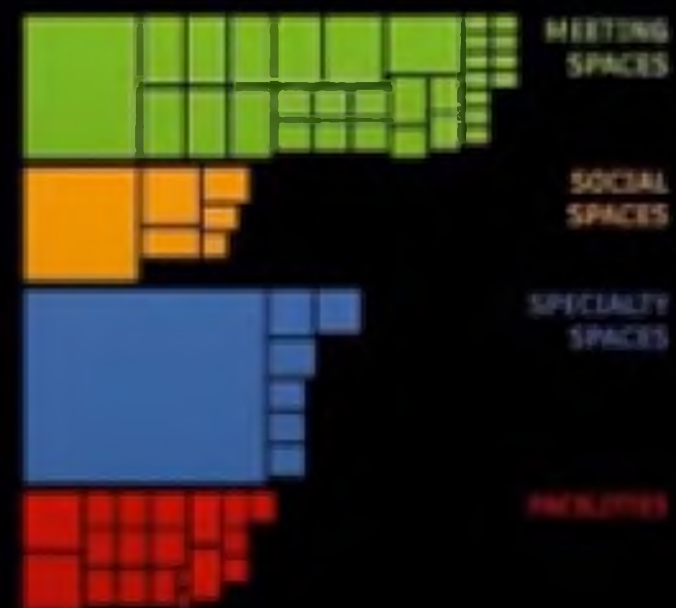
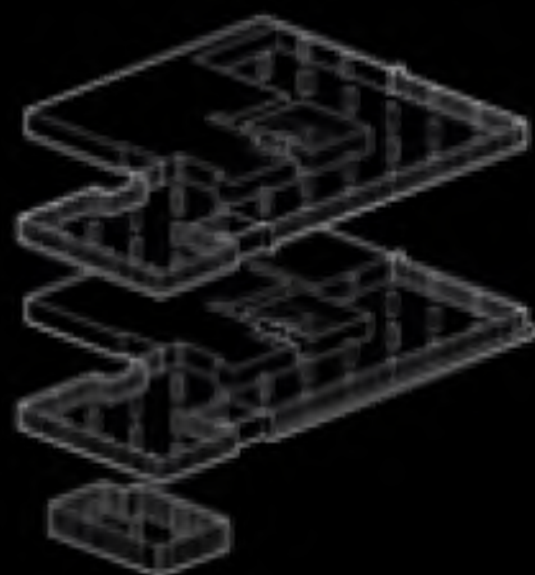
Далее определяются функциональные зоны и приблизительное их расположение в зависимости друг от друга.

Также определяются проблемные зоны.

GENERATIVE DESIGN
FOR ARCHITECTURE



...and the **constraints of program**—including meeting rooms, social spaces, and the number of people that will work there.



MEETING
SPACES

SOCIAL
SPACES

SPECIALTY
SPACES

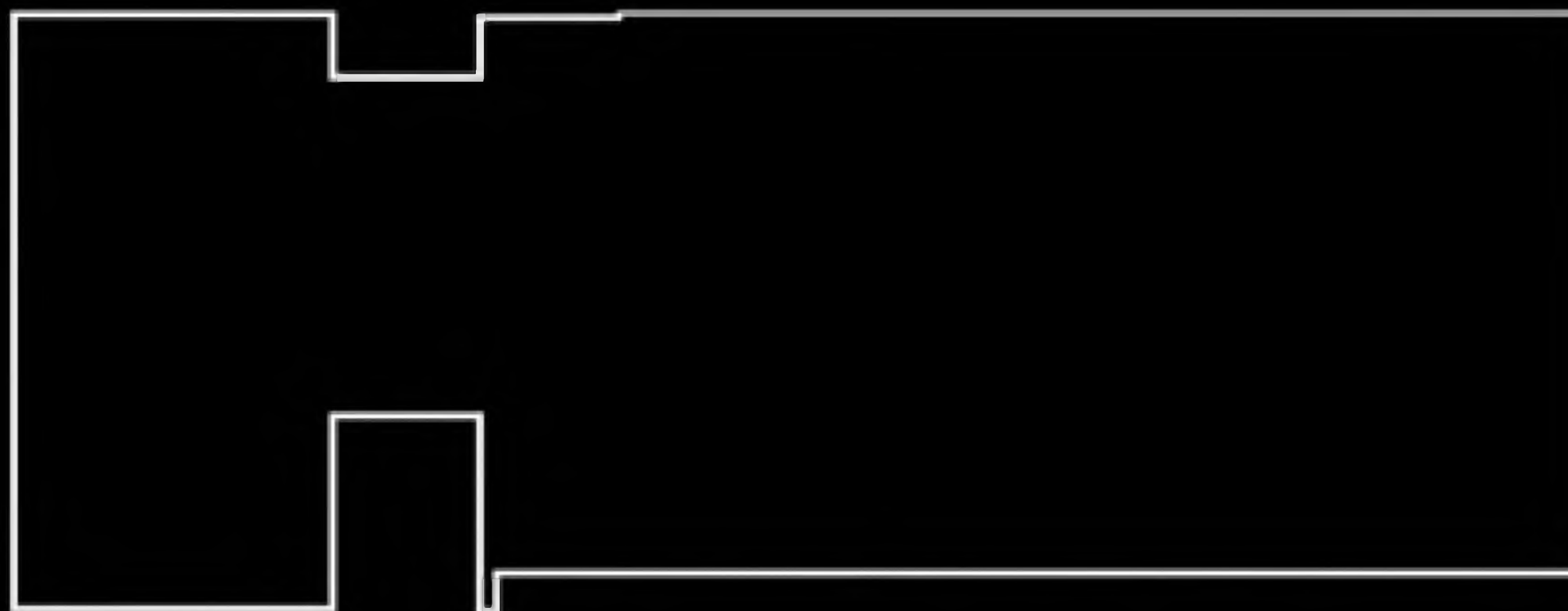
PRIVATE



Следом идет процесс построения алгоритмической системы, которая основывается на собранных заведомо данных, которые необходимо учесть в проектировании.

На базе данной системы искусственный интеллект и будет разрабатывать планировочные решения.

GENERATIVE DESIGN FOR ARCHITECTURE



Adjacency preference



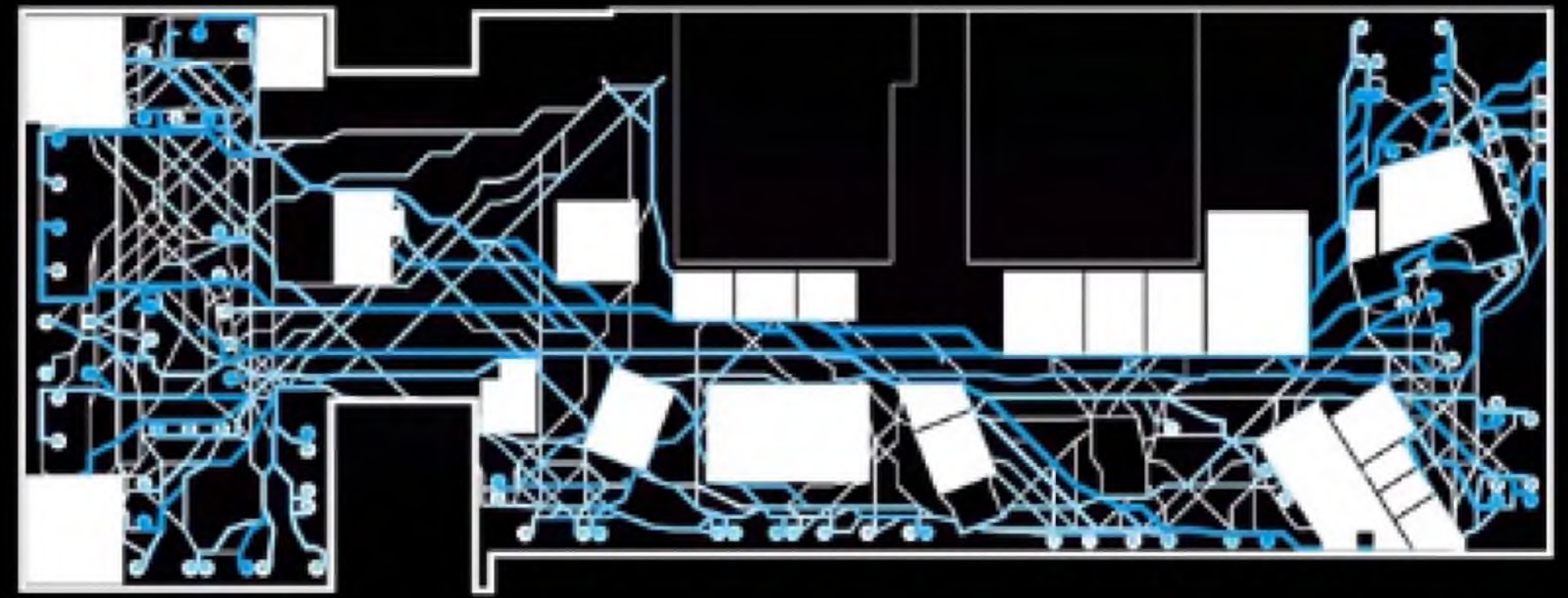
Work style preference

Two of the goals required gathering **data from individuals and teams** and computing complex factors of **human experience** that are typically overlooked or over-simplified.

| GENERAL STATS | WORKSPACE TYPE | MEETING ASSOCIATION | TIME ASSOCIATION | INTERACTION / OFFICE | SATISFACTION / DESK | PRODUCTIVITY | AMBIENT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| <table border="1"> <tr><th>Person</th><th>Count %</th></tr> <tr><td>Person</td><td>9 (20%)</td></tr> <tr><td>Team</td><td>11 (25%)</td></tr> <tr><td>Team</td><td>11 (25%)</td></tr> <tr><td>Team</td><td>11 (25%)</td></tr> <tr><td>Team</td><td>11 (25%)</td></tr> </table> | Person | Count % | Person | 9 (20%) | Team | 11 (25%) | Team | 11 (25%) | Team | 11 (25%) | Team | 11 (25%) | <table border="1"> <tr><th>Room</th><th>Count %</th></tr> <tr><td>Room</td><td>2 (5%)</td></tr> <tr><td>Room</td><td>2 (5%)</td></tr> <tr><td>Room</td><td>2 (5%)</td></tr> <tr><td>Room</td><td>2 (5%)</td></tr> <tr><td>Room</td><td>2 (5%)</td></tr> <tr><td>Room</td><td>2 (5%)</td></tr> <tr><td>Room</td><td>2 (5%)</td></tr> <tr><td>Room</td><td>2 (5%)</td></tr> <tr><td>Room</td><td>2 (5%)</td></tr> <tr><td>Room</td><td>2 (5%)</td></tr> </table> | Room | Count % | Room | 2 (5%) | Room | 2 (5%) | Room | 2 (5%) | Room | 2 (5%) | Room | 2 (5%) | Room | 2 (5%) | Room | 2 (5%) | Room | 2 (5%) | Room | 2 (5%) | Room | 2 (5%) | <table border="1"> <tr><th>Person</th><th>Count %</th></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> </table> | Person | Count % | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | <table border="1"> <tr><th>Person</th><th>Count %</th></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> </table> | Person | Count % | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | <table border="1"> <tr><th>Person</th><th>Count %</th></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> </table> | Person | Count % | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | <table border="1"> <tr><th>Person</th><th>Count %</th></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> </table> | Person | Count % | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | <table border="1"> <tr><th>Person</th><th>Count %</th></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> <tr><td>Person</td><td>1 (2%)</td></tr> </table> | Person | Count % | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) | Person | 1 (2%) |
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| Team | 11 (25%) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Team | 11 (25%) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Person | 1 (2%) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Person | Count % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Person | 1 (2%) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Person | Count % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Person | 1 (2%) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Person | 1 (2%) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Person | Count % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Person | 1 (2%) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Person | 1 (2%) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Person | 1 (2%) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Person | 1 (2%) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Person | 1 (2%) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Person | 1 (2%) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Person | Count % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Person | 1 (2%) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Person | 1 (2%) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Person | 1 (2%) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Person | 1 (2%) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

GENERATIVE DESIGN FOR ARCHITECTURE

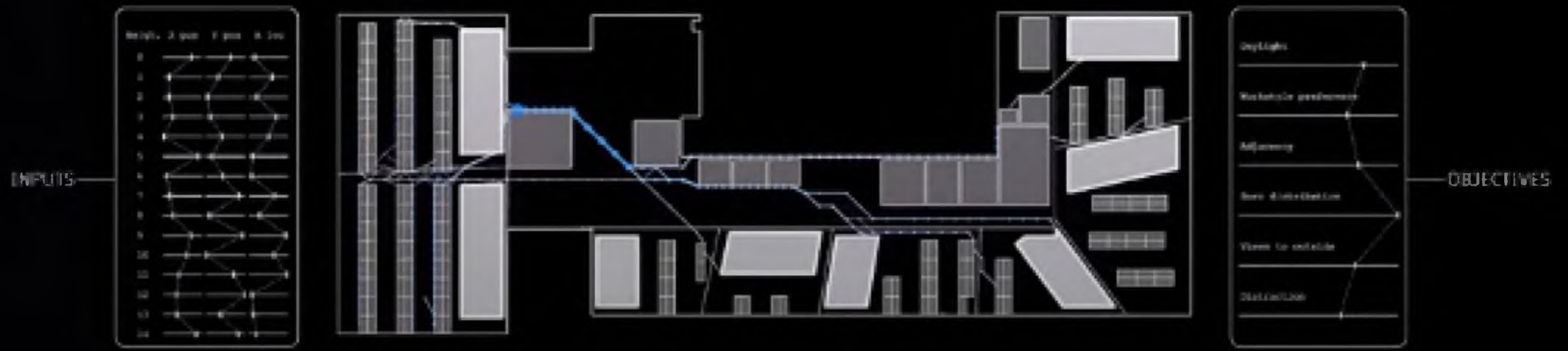
- 1. GENERATE
- 2. EVALUATE
- 3. EVOLVE
- 4. EXPLORE



Далее компьютер выполняет оценку имеющихся данных и генерирует последовательность операций, которые ему предстоит совершить.

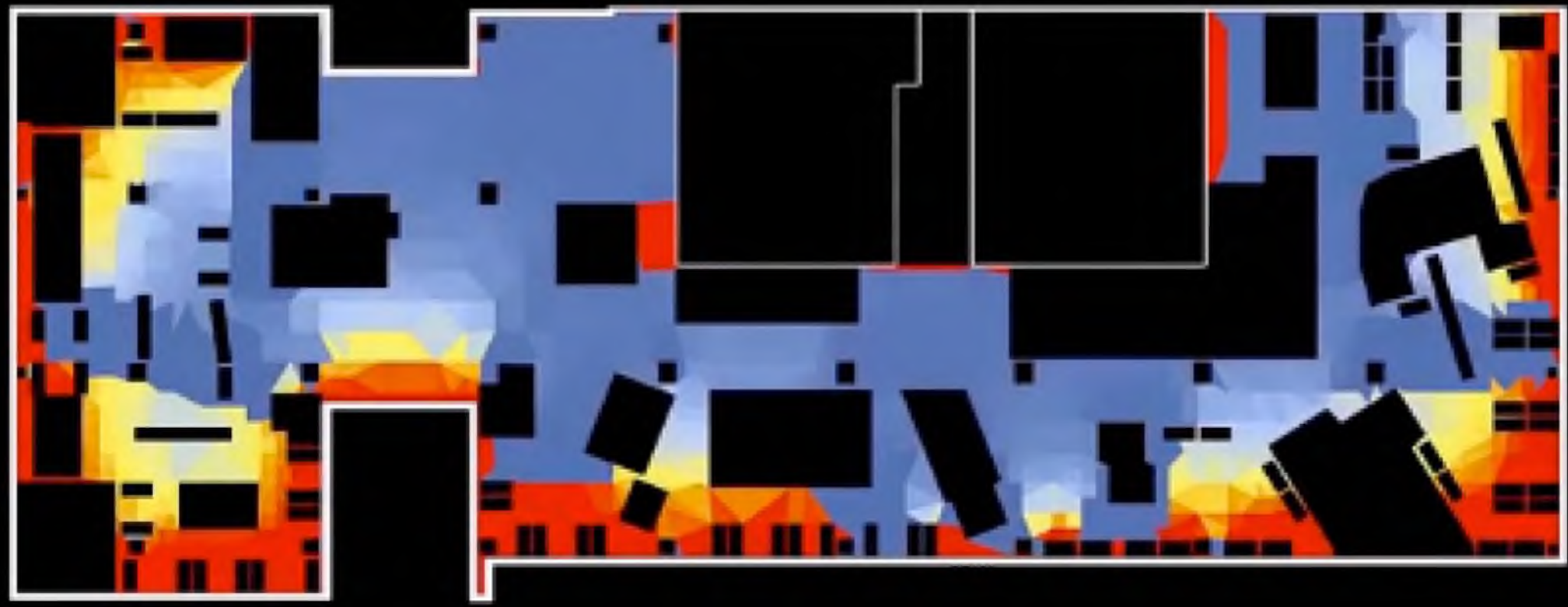
В данном процессе ИИ уже частично занимается подбором вариантов сценария.

2A: Adjacency preference minimizes the travel distance between collaborating teams and preferred amenities.



GENERATIVE DESIGN FOR ARCHITECTURE

- 1. GENERATE
- 2. EVALUATE
- 3. EVOLVE
- 4. EXPLORE



2E: Daylight maximizes the availability of natural light in the office.

Следом ИИ примеряет на данную систему все данные, которые были заложены изначально в алгоритм.

В них входит, например, инсоляция, метеоданные, сейсмика, маршруты людей, их потребности, различного рода нормативы и т. д.





Данный слайд демонстрирует процесс генерации проектных решений.

Вы можете увидеть, как искусственный интеллект генерирует более 3 000 уникальных вариантов планировки, сопоставляет их между собой, выбирает лучшие из них, и прогоняет вновь по заданному алгоритму.

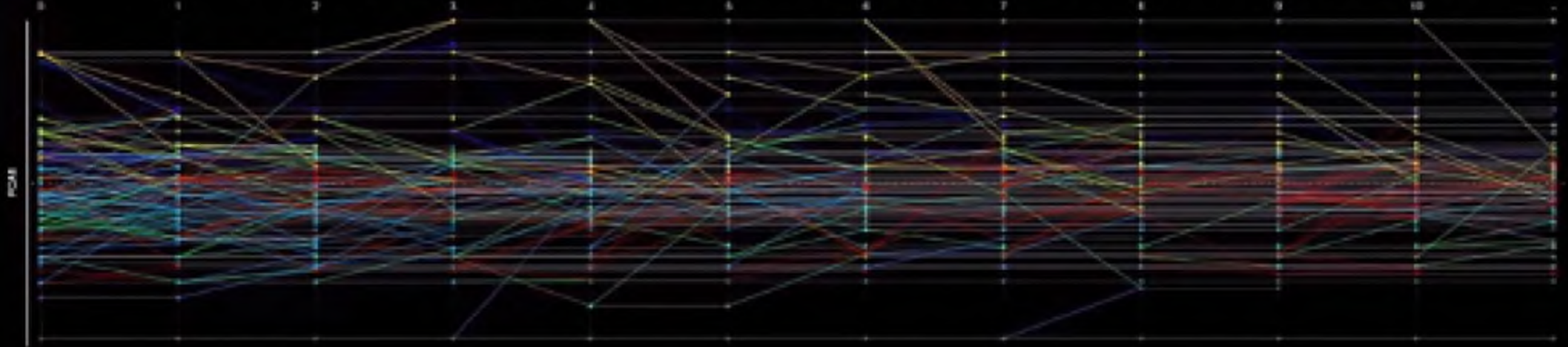
GENERATIVE DESIGN FOR ARCHITECTURE

- 1. GENERATE
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- 4. EXPLORE



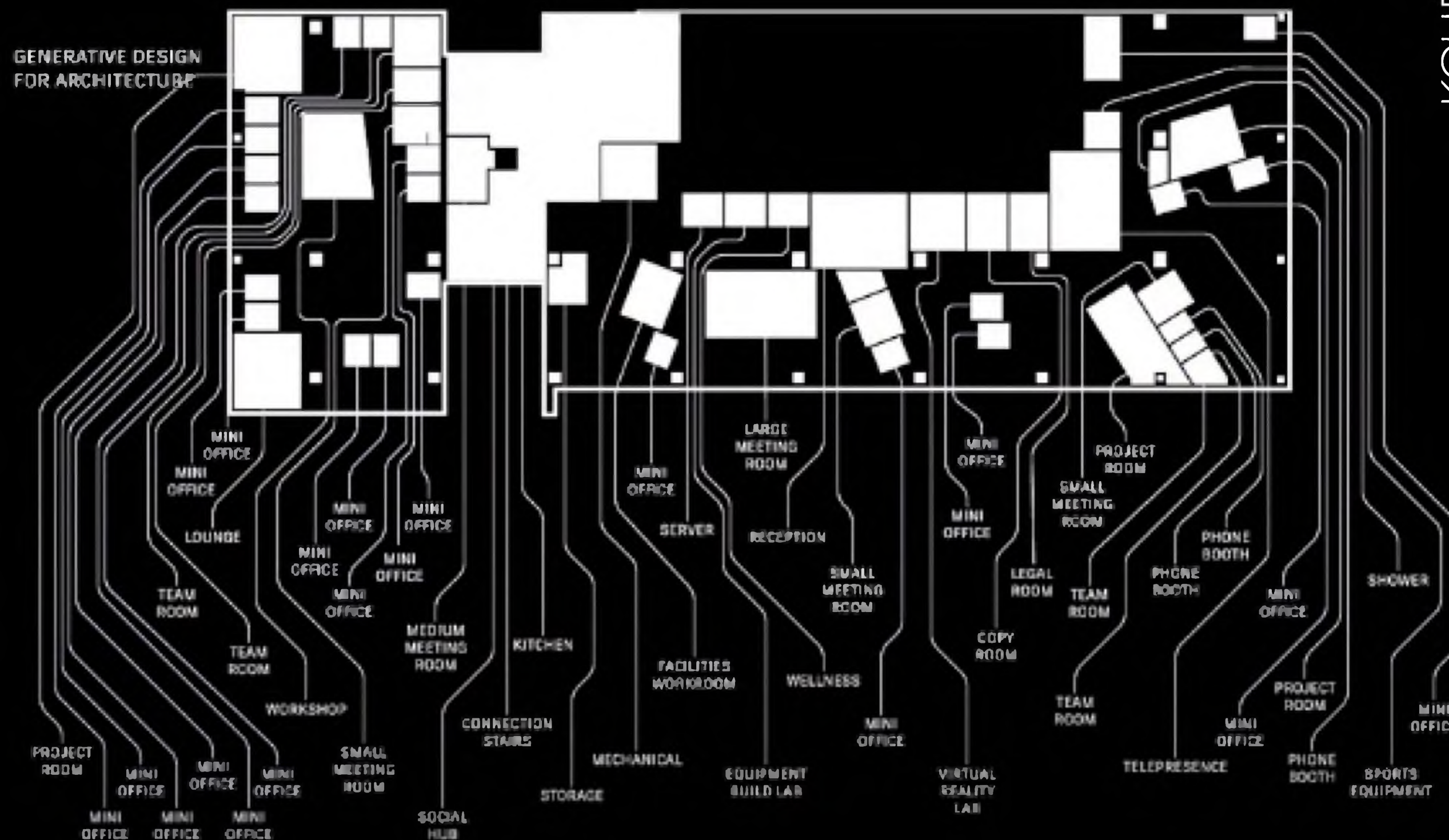
STEP 3: EVOLVE

Automatically create thousands of design options that meet the complex goals.





В итоге мы получаем наиболее оптимальную планировочную модель, которая содержит в себе лучшее из 3 000 вариантов, сгенерированных в процессе.



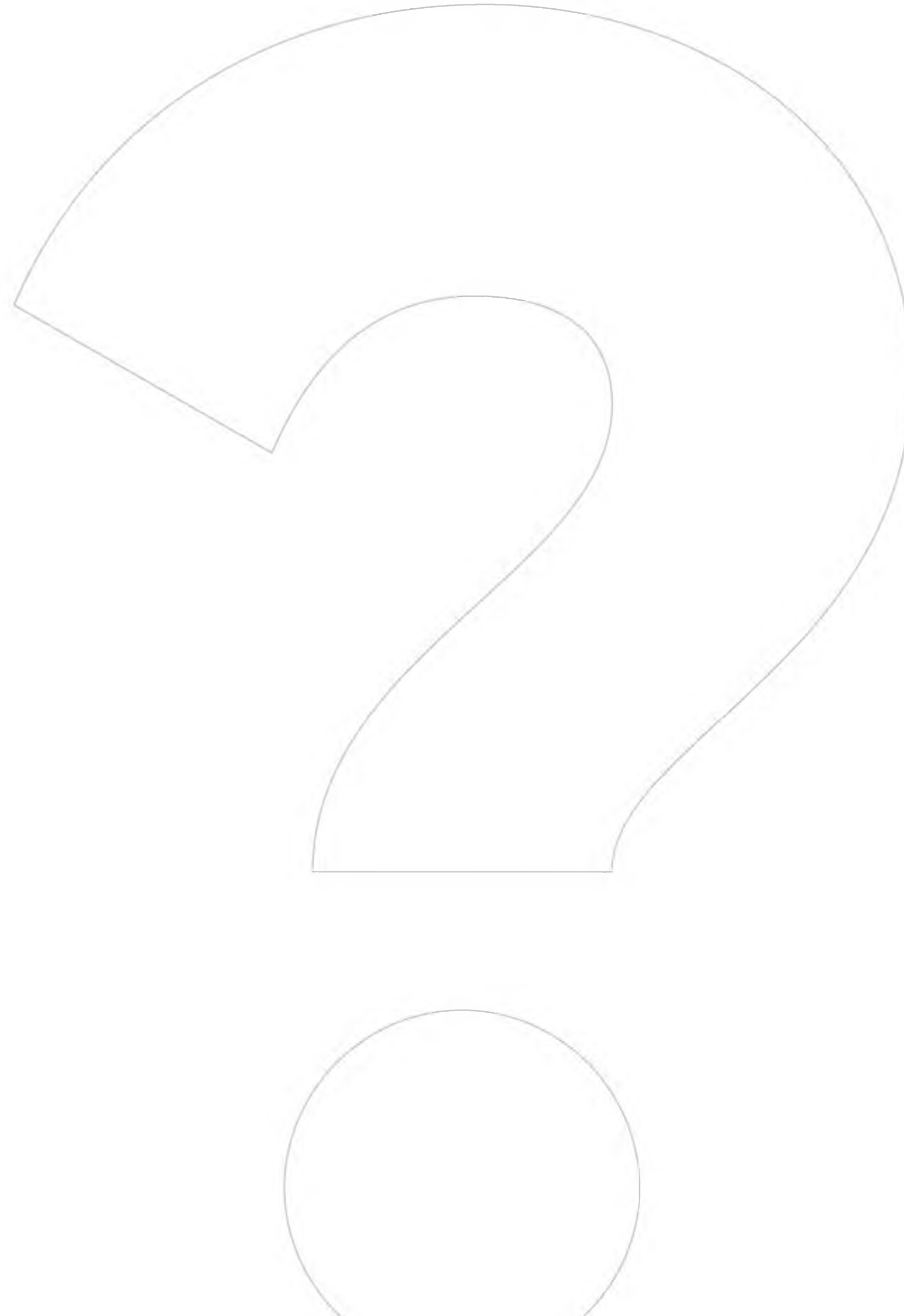


Выводы?

Несмотря на то, что непосредственно архитектору также сложно предсказать результат работы на начальном ее этапе, суть применения данного инструмента заключается в том, чтобы сгенерировать наибольшее возможное число вариантов и определить лучшие из них.

Также можно использовать методы генеративного проектирования для решения локальных задач, что можно рассматривать как своего рода сотрудничество человека и искусственного интеллекта.

Так или иначе, судить об этом довольно рано. Данная тема нуждается в дальнейшем изучении архитектурным сообществом, а также в развитии как самого метода, так и способов его применения в разработке проектных решений.





Благодарю за внимание!

КСНП-2020