

PRD: Automated TestFit

Document Log

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Basic definitions and terminology

[\[link to edit definitions\]](#)

Term	src	Definition	ref
Activity-based workstyle	dk	The activity-based workstyle involves designing the workspace around specific activities or tasks, rather than around specific individuals or teams	
Adjacency	sm	Defining the requirement of how closely each block/facility should be place with respect to other block/facility. Normally defined using matrix by defining priority of each facility against all other facilities by a priority number	
Adjacency matrix	tech	In graph theory and computer science, an adjacency matrix is a square matrix used to represent a finite graph. The elements of the matrix indicate whether pairs of vertices are adjacent or not in the graph	1
ATF	sm	An abbreviation for the Automated TestFit	
ATF process	sm	The process of running an ATF optimization. This process is a long running process and can take hours depending on the complexity of the floor plan, size, number of nodes, computational power, number of iterations, error threshold.	
bin packing algorithm	tech	The bin packing problem is an optimization problem, in which items of different sizes must be packed into a finite number of bins or containers, each of a fixed given capacity, in a way that minimizes the number of bins used.	1
Block subtype adjacency	sm	The spatial adjacency priority between different block subtypes, i.e. blocks to be located near to or far from other blocks.	
Circulation	dk	Available or unoccupied pathway or corridors within a Space to move around, after defining the Sections .	
Constraints	tech	In mathematical optimization, constrained optimization (in some contexts called constraint optimization) is the process of optimizing an objective function with respect to some variables in the presence of constraints on those variables.	1
Graph	tech	A graph is a structure amounting to a set of objects in which some pairs of the objects are in some sense "related". The objects correspond to mathematical abstractions called vertices (also called nodes or points)	1

Term	src	Definition	ref
		and each of the related pairs of vertices is called an edge (also called link or line)	
Hoteling workstyle		The hoteling workstyle involves providing a pool of flexible workspaces that can be used by different employees on an as-needed basis.	
Nearest Neighbors	tech	Nearest neighbor search (NNS), as a form of proximity search, is the optimization problem of finding the point in a given set that is closest (or most similar) to a given point. Closeness is typically expressed in terms of a dissimilarity function: the less similar the objects, the larger the function values.	1
Neighborhood workstyle	dk	<p>A neighborhood workstyle in an office space refers to a design that divides the workspace into different areas or zones, each with a specific purpose or function. This type of workstyle is intended to provide employees with a range of options for where and how they work, and to create a more flexible and dynamic working environment.</p> <p>Examples of different types of neighborhoods or zones that might be included in a neighborhood workstyle office space:</p> <ol style="list-style-type: none"> 1. Quiet zone: This area is designated for focused, individual work that requires minimal distractions. It may include private offices or cubicles, as well as quiet rooms or pods. 2. Collaboration zone: This area is designed for teamwork and collaboration, and may include open plan workspaces, conference rooms, or team rooms. 3. Socialization zone: This area is intended for socializing and relaxation, and may include areas such as a lounge or a kitchen. 4. Flexible zone: This area is designed to be adaptable to a range of different activities, and may include adjustable desks, seating, and other flexible furniture. 	
Objective function	tech	The objective function is a mathematical equation used to maximize a desired outcome by setting a target for a specific output. It uses the relationship between variables to calculate the final result. In simpler terms, it is a tool that helps organizations reach their goals	
Org unit	dk	Aka. Department. Each company contains org units ex. Engineering, CS, Finance ..	
Org-level adjacency	sm	The spatial adjacency priority between org. units and different levels in the building	

Term	src	Definition	ref
Org adjacency	sm	The spatial adjacency between each pair of org units for example, how close should be engineering to IT ?	
Proximity	sm	Expected nearness/farness with the points of interest (POI)(Entrance/Exits/Stairs/Lifts) Defined using distance value (eg. max 5 feet or min 3 feet from Entrance)	
Smart Zoner	sm	An AI model that continuously learn from the real human zoning process using Reinforcement learning algorithms	1
Stacking diagram	tech	A stacking diagram is a visual representation of the total area occupied by all the spaces in a building, arranged by floor. It can be two-dimensional or three-dimensional and may use colors to show specific details. Stacking diagrams are commonly used to represent buildings, such as residential buildings.	1
Workstyle	dk	<p>A workstyle refers to the way in which an individual or team approaches their work, including their preferred methods and habits. It can also refer to the physical environment in which they work, including the layout, design, and amenities of the workspace. Different workstyles may be better suited to different types of work, and may vary based on factors such as an individual's personality, work preferences, and the nature of the work itself.</p> <p>Some common elements that can define a workstyle include:</p> <ol style="list-style-type: none"> 1. Location: This can refer to where the work is done, such as in an office, a home office, or a coworking space. 2. Collaboration: This can refer to the level of interaction and teamwork involved in the work, such as working independently versus working as part of a team. 3. Flexibility: This can refer to the degree of flexibility in terms of when and where the work is done, such as working fixed hours in an office versus having a more flexible schedule. 4. Structure: This can refer to the level of structure and routine in the work, such as having a set schedule versus having a more open-ended or project-based workstyle. 5. Physical environment: This can refer to the layout, design, and amenities of the workspace, such as an open office plan versus a private 	

Term	src	Definition	ref
		office, or the availability of amenities such as a kitchen or lounge.	
WPS Backoffice	sm		
Zone	dk	Is a group of book rooms that serve similar function. For example, collaboration area zone, financial department zone, and training area zone.	1
Zone-zone adjacency	sm	The spatial adjacency between each pair of zones within an org unit in a floor plate. Example : how close should be the workpoints to the closed formal collaboration spaces?	1
Definitions	sm	Definitions in the context of an ATF (Automated Test Fit) problem refer to the set of rules and relationships that govern how different entities in the system interact with each other. These definitions may include adjacency and proximity relations , constraints , and path finding relations between different entities in the system. These definitions are used to help guide and optimize the test fit process, ensuring that the final design is functional and efficient.	
Point of interest	sm	<p>General definition: In spatial data science, (POI) is a specific point location, or useful site, defined mainly by its geographical coordinates (longitude and latitude). It refers to a place or destination of potential interest. It can be a tourist attraction, a hotel, a restaurant, an ATM, a pharmacy, a medical center, a store, a gas station, or any other category used in modern car navigation systems.</p> <p>Saltmine context definition: It is any physical element in the floor plan that is defined by its x,y,z coordinates and can have constraint attached to it. For example,</p> <ul style="list-style-type: none"> - The floor entry location: [x, y]. - The floor entry constraint : maximum 30 meters from any point on the floor plan. 	
Data Shuffling	tech	Shuffling data can be used to find the global optimum of a given problem. This is done by randomly rearranging the data in order to explore different possible solutions. Shuffling can help to explore a larger space of possible solutions and thus increase the chances of finding the global optimum. Additionally, shuffling can help to avoid local minima by avoiding the same solutions that have been explored before. Shuffling can be done with algorithms such as gradient descent, particle swarm optimization, and genetic algorithms.	

dk : domain knowledge

sm : Saltmine term

tech : Technical term

Introduction

Test fit is a term used in the field of building design and corporate real estate to refer to the process of verifying that a proposed layout or design for a space will function effectively and efficiently. This process may involve creating a digital model of the space and using it to experiment with different furniture configurations and design elements to determine their suitability for the space.

The "Automated Test Fit" project aims to address the challenges of space allocation for Saltmine users by optimizing the allocation of facilities in the workspace while considering constraints such as adjacency and proximity needs. For this project, the focus will be on space planning within a single floor or level.

Having an automated test fit feature will give Saltmine a competitive advantage over other players in the market. In general, test fit is an important consideration in building and space planning, as it helps to ensure that the final design will be functional and efficient.

Key-value proposition

- **Cost and Time Efficiency:** The current test fit process is done manually, which is time-consuming and costly. By automating certain steps and procedures, we propose to reduce the test fit timing from 3 weeks to 1 day, while still allowing for multiple scenarios to be tested.
- **One-Click Magic Test Fit:** With our one-click magic automated test fit, anyone can design a space with ease and flexibility to edit and adjust as needed.
- **Data-Driven Test Fit:** The automated test fit will be driven by data on utilization, employee experience, and the future of work, which is likely to improve space utilization and employee experience and productivity.
- **Intelligent Test Fit:** Using [block-level intelligence and standardized block attributes](#), our intelligent test fit system will help to ensure that the final design is optimized for efficiency and effectiveness.

Goals

The goal of the current project is to:

- **Save time on repeated test fit tasks:** By automating certain aspects of the test fit process, we aim to reduce the time and effort required to complete test fit tasks.
- **Provide customers with a one-click automated test fit:** Our goal is to make the test fit process as easy and user-friendly as possible, with a one-click automated option that allows anyone to design a space with ease.
- **Use data to drive design and test fit:** By using various data sources and fusions, we aim to better reflect our customers' culture, branding, and business objectives in the design and test fit process.

- **Achieve seamless integration with other modules:** Our test fit system will be seamlessly integrated with other relevant modules to ensure smooth and efficient operation.

Vision for the product

The vision is to be able to generate multiple testfit designs with a minimal user interaction. We call this approach, the **one click magic**. That means minimizing user interaction, minimizing elements (buttons, input fields, ...) and maximizing user experience.

Proposed Solution

Description of the proposed solution

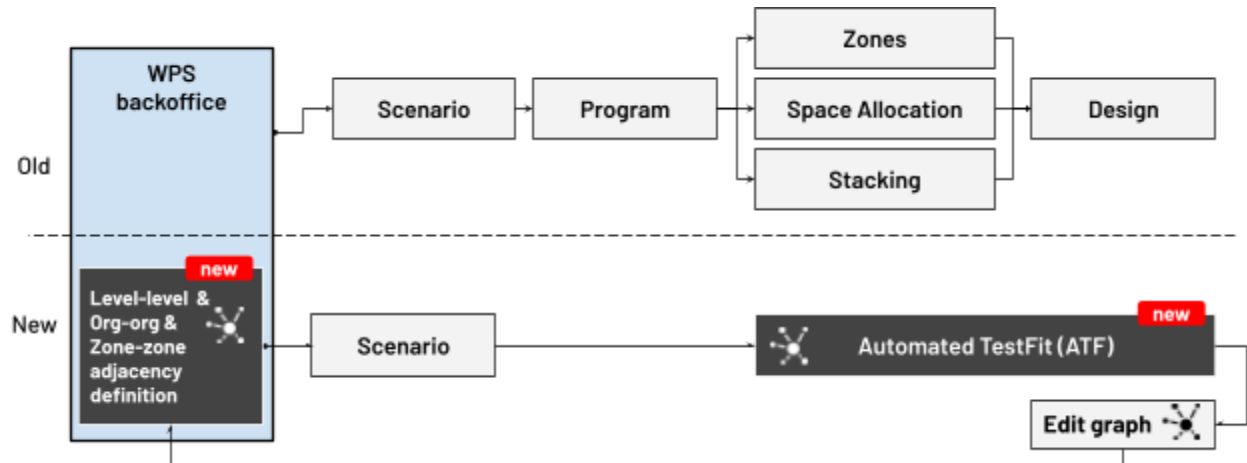
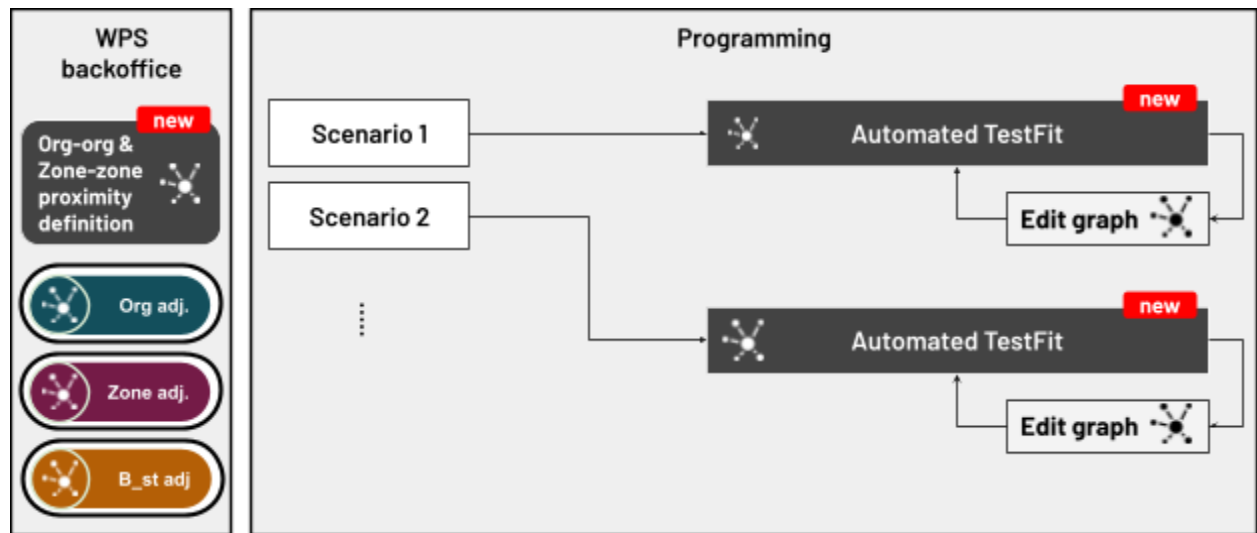


Figure 2: Vision



B_st: Block subtype

Figure 3

Our solution aims to reduce the need for manual input from the user. [Definitions](#) can be added or modified at any time during the automated test fit process through the WPS backoffice. The transition from scenario to design should be done with a single click: select the graph template/configuration from the WPS backoffice and click "generate."

When the "generate" button is clicked, the ATF engine will:

- Auto-generate floor plans for each level based on the adjacency and proximity matrix [definitions](#) from the WPS backoffice.
- Allow the user to select one of the top 3 designs and make changes to the relation graph.
- Allow the user to edit inputs at any stage. This will prompt the user to save as a new ATF file or overwrite the existing ATF file.

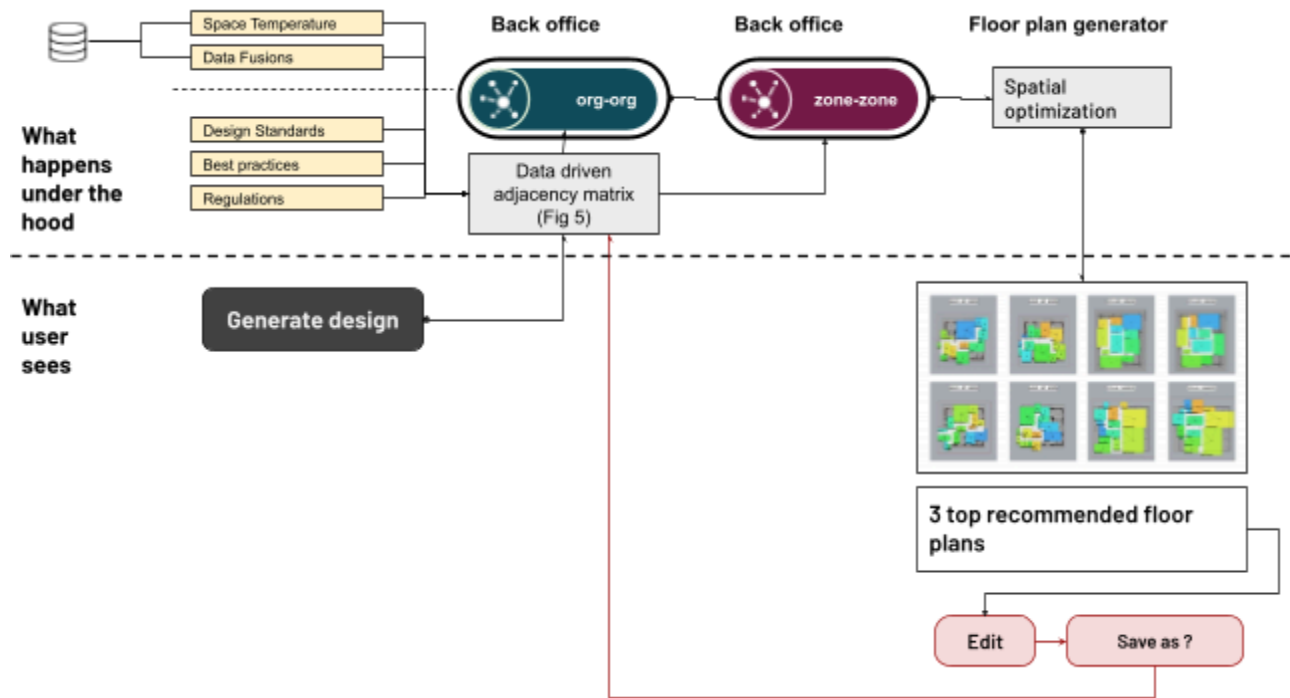


Figure 4 The ATF workflow

WPS backoffice inputs

To reduce the amount of interaction required from the user, we will provide a list of choices for the user to choose from. These choices will automatically populate the adjacency and proximity based on the database of assumptions. The database will improve and fine-tune itself over time by learning from our past designs and customer behavior. This continuous learning process is called the Smart Zoner. However, the user can still customize the input and add any new adjacency graphs. The next sections will introduce the Automated Test Fit inputs for the WPS back office.

Data driven ATF generation

To facilitate the process of completing adjacency metrics, we will adopt a data-driven approach. The Automated Test Fit (ATF) module will be able to connect to a range of data sources, such as [utilization data, employee experience data, and spatial proximity data](#) ([refer to the logic here](#)), to automatically generate various adjacency matrices (as illustrated in Figure 5). This will enable users to easily incorporate and utilize different data sources in the creation of the necessary matrices.

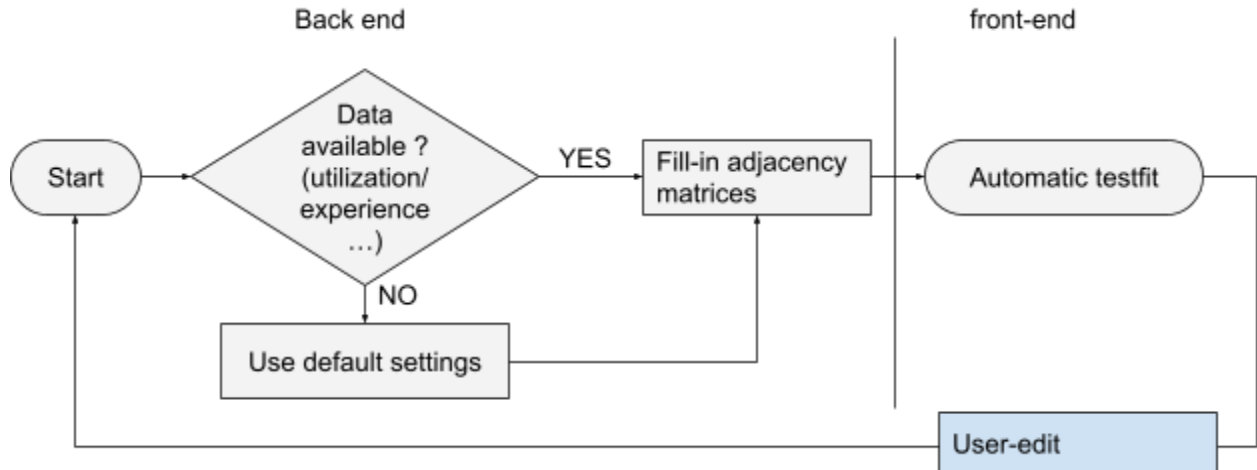


Figure 5. Schematic flowchart Data driven adjacency matrix definition

ORG. adjacency graph

The organization-to-organization (ORG adj.) adjacency graph is used to determine the priority of allocating different organizational units near to each other in the floor plan. It also helps to distribute these units on different floors (stacking). The adjacency graph can be automatically filled with values from utilization and spatial proximity data if available. If such data is not available, the graph will be filled with default values. The user can also manually edit or change the adjacency graph at any time. The ORG-ORG adjacency graph is structured with the following elements:

- Rows: organizational units
- Columns: organizational units
- Cells: weightage

Example

	CS	Engineering	Finance	Common
CS	–			
Engineering	2	–		
Finance	3	1	–	
Common	5	5	4	–

Assumptions and default settings

Assumption are driven by the following factors:

1. The company's industry [research needed]
2. Locality
3. Design standards

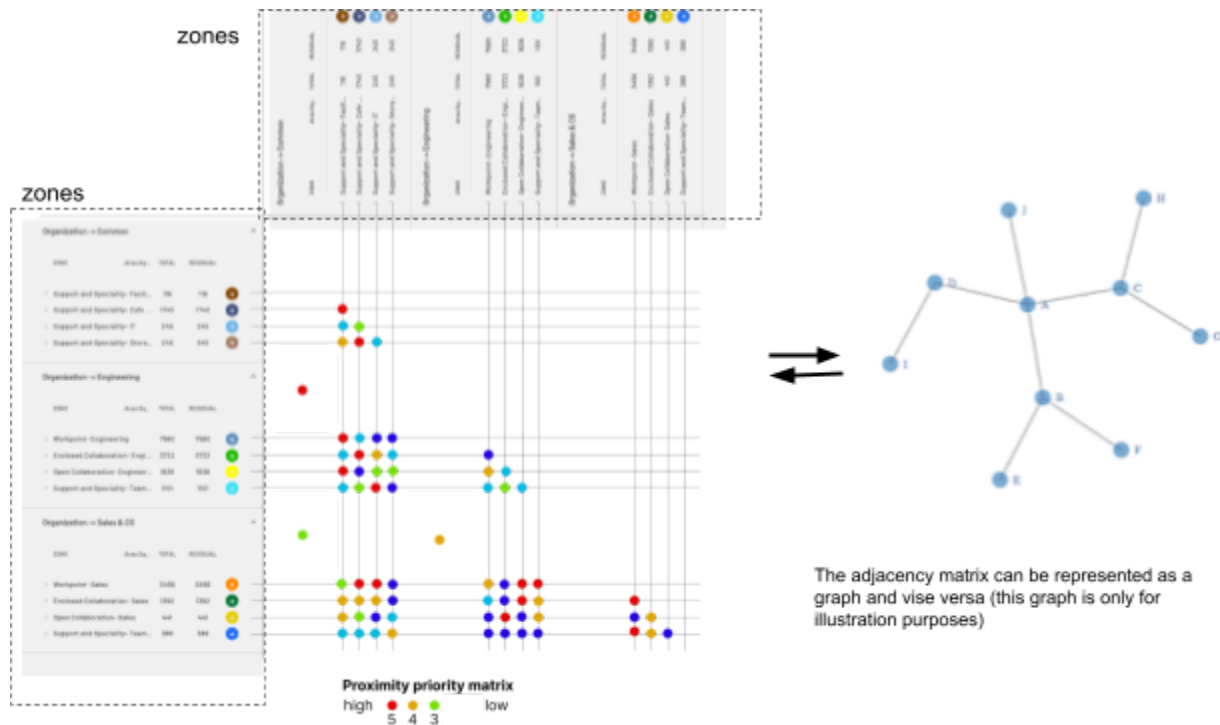
ZONE adjacency graph

Data-driven inputs

If the user has utilization/experience data, this adjacency graph will be auto-filled with the values fused from the data. Otherwise, it will be auto-filled by the default settings (Figure 5). The user can manually edit/override the adjacency graph at any point of time. The zone-zone adjacency graph is structured as follows:

- **Rows:** zones
- **Cols:** zones & amenities
- **Cells:** Weightage (from 0 to 5)

Example



Default settings and assumptions

If the user doesn't have utilization data to auto-fill the adjacency graph, then the following data sources will be used instead:

1. The company's industry.
2. Work style (open office, team-zones, closed offices, activity-based workspace, neighborhood) [research needed]
3. Culture (clan culture, adhocracy culture, market culture, hierarchy culture, transparency culture ...)
4. Locality regulations
 - a. Safety and security regulations (maximum distance from fire escape).

- b. Health and hygiene regulations.
- 5. Design standards

BLOCK SUBTYPE adjacency graph

Data driven inputs

If the user has utilization/experience data, the block subtype adjacency graph will be auto-filled with the values fused from the data. Otherwise, it will be auto-filled by the default settings (Figure 5). The user can manually edit/override the adjacency graph at any point of time. The block subtype-block subtype adjacency graph is structured as follows:

- **Rows:** block subtypes
- **Cols :** block subtypes & **amenities** (zone entry, windows, AV, whiteboard, ...).
- **Cells :** Weightage (from 0 to 5)

Project Scope

Description of the project scope

The Auto Testfit will have two parts: the designer module and the WPS back-office module.

- The designer module will show the results and progress of the Auto Testfit ([Figma preview](#)).
- WPS back-office module will be used to link and manage data ([Figma mockups](#)).

List of Features Needed

Designer Module:

- **Automated TestFit grid view:**
 - **To show the different ATF processes ([Figma file](#)).**
 - In-progress ATF process.
 - The user can preview the top score design so far.
 - The user can see the estimated time to finish.
 - The user can open the design view to see detailed view of the progress (See [bookmark](#))
 - Finalized ATF process.
- **Designer screen viewer:** for viewing ATF alternatives.
 - Real-time synchronous updating: the ability to update the design in real time at a set interval.
 - To show the progress of a design in progress.
 - To enable the user to like/dislike the design at any time and this feedback will refine the optimization objectives.
 - Optimization Progress chart View
 - Residual view to show different scores ([Link](#)).

Data input (Configuration) :

- **Adjacency matrices editor ([Example demo here](#)).**
 - Org-org adjacency matrix input
 - Zone-zone adjacency matrix input

- Block subtype-Block subtype adjacency matrix input.
- Proximity to points of interests.
- Constraints (minimum corridor width, max travel distance)
- **Interactive graph editor/viewer** ([Example demo component](#) | [Example video](#)).
 - The interactive graph editor represents the bubble diagram used in architecture design.
 - The interactive graph editor is a visual interface to the Adjacency matrix editor.
 - It is updated in real-time with inputs from the Adjacency matrix editor and vice versa.
- Ability to convert the maximum escape distance into constraints.
- Capability to import or upload adjacency/proximity matrix from previous project or from the local machine.
- Capability to automatically fill-in adjacency/proximity matrix from utilization and other proximity data fusions. ([Example here](#) - [Calculation logic here](#))
- Capability to extract adjacency/proximity matrix from existing floor plans.
- Capability to convert rules and regulations into adjacency/proximity matrix.
- Capability to convert different workstyles into adjacency/proximity matrix.
 - Traditional workstyle,
 - Tech workstyle,
 - Hybrid workstyle,
 - Neighborhood workstyle.

Designer back office

- Catalog of existing designer projects and their adjacency and proximity matrix.
- Catalog of building regulations from different locales and how they translate into adjacency and proximity matrices.
- Catalog of workstyles and their representation in the form of adjacency/proximity matrices.

ATF process (backend).

These are the steps used to implement one ATF process ([more technical details can be found here](#)).

Process	Inputs	Outputs
Auto Circulation	<ul style="list-style-type: none"> ● Building physical elements (points of interest) . for example entrance, fire exit, windows, water points, columns and walls. ● Core and shell. ● Program. 	Auto Circulation (scoring and ranking top 3 options).
Auto Zone Fitting	<ul style="list-style-type: none"> ● Building physical elements ● Programme Output ● Proximity ● Adjacency 	<ul style="list-style-type: none"> ● Space allocation (scoring and ranking top 3 options). ● Additional Intelligence (auto Learning)

Process	Inputs	Outputs
Auto Block Fitting	<ul style="list-style-type: none"> Section-wise Block List Block intelligence data. Proximity Adjacency 	<ul style="list-style-type: none"> Secondary Circulation Block allocation (scoring and ranking top 3 options). Additional Intelligence (auto Learning).

Key User Requirement

Target User Profiles

The following user profiles will be referred to as user

- Designers.
- Workplace planners.

User stories

S.N	User Story	Priority
Data definitions		
	As a user, I want to be able to edit the adjacency and proximity matrices for Org-Org, Zone-Zone, and Block Subtype-Block Subtype relations using a table view	1
	As a user, I want to be able to edit the adjacency and proximity matrices for Org-Org, Zone-Zone, and Block Subtype-Block Subtype relations using an interactive graph view as follows: <ol style="list-style-type: none"> Linking/unlinking nodes. Adding attributes to each node (name, color, max area, workstyle). Adding attributes to each link (relation weight, max distance). 	1
	As a user, I want to be able to import or upload existing adjacency or proximity matrices from previous projects, existing templates, or local CSV files.	1
	As a user, I want to be able to view and edit the table and the graph views in the designer module directly without going back and forth to the WPS.	1
	As a user, I want to be able to delete adjacency or proximity matrices and start from scratch.	1
	As a user, I want to be able to save and overwrite adjacency or proximity matrices.	1
	As a user, I want to be able to generate adjacency matrix from utilization and proximity data with filters: ref1 ref2 <ol style="list-style-type: none"> Filter by site, Filter by date range, 	1

	<ol style="list-style-type: none"> Filter by building, Upload data if no data exists. 	
	As a user, I want to be able to convert any floor plan from previous designer projects into adjacency and proximity matrix.	3
	<p>As a user, I want to be able to adjust the adjacency and proximity matrix based on my selection of different work styles:</p> <ol style="list-style-type: none"> Traditional workstyle, Tech workstyle, Hybrid workstyle, Neighborhood workstyle, and Custom workstyle 	2
	As a user, I want to be able to create, retrieve, update, and delete custom workstyles.	2
Designer module		
	As a user, I want to be able to load WPS backoffice ATF setup.	1
	As a user, I want to be able to CRUD ¹ an ATF process.	1
	As a user, I want to be able to pause, resume, or duplicate any ATF process.	1
	<p>As a user, I want to be able to view ATF processes as a grid or list view with filters and sorting capability.</p> <ol style="list-style-type: none"> View basic information of each ATF process such as: <ol style="list-style-type: none"> Top score, Time spent / time estimate. Current cost, Current progress (if the process is still in progress), Thumbnail of the top score design for each process. Sort by date, score, n_of_iterations, time spent, last updated. Filters : completed, in progress, score within range (x, y). 	1
	As a user, I want to be able to preview any existing ATF process by clicking on the preview button, and this will show a sidebar showing a summary of the process and/or current progress.	1
	As a user, I want to be able to open any ATF process by clicking on the open button and it will open the ATF process in a new page. (please refer to the mock-ups)	1
	<p>As a user, I want to view the top 3 highest scores in the ATF process and show:</p> <ul style="list-style-type: none"> the score of each objective as a radar chart (mock-up link same as above): <ul style="list-style-type: none"> Adjacency score, 	1

¹CRUD: Create, Retrieve, Update, and Delete.

	<ul style="list-style-type: none"> ○ Proximity score, ○ Path finding score, ○ Utilization score, ○ Circulation score, ○ Regulations score. ● Thumbnail of the design. 	
	As a user, I want to be able to click on one of the top 3 designs and open any of them in the designer viewer and have the ability to edit the adjacency/proximity matrix	1
	As a user, I want to be able to shuffle the ongoing ATF process to generate more variational permutations.	2

Out of the scope.

1. Currently, the product only allows for one level of automated test fit and does not provide support for multiple levels or the ability to zone across different levels in stacking diagrams.

Linked Documents

Please provide links to documents regarding solutioning here; e.g.

- [Technical specifications](#)
- [Use case scenarios](#)
- Floor plan corridors examples (WIP)
- [Use cases and guidelines](#)
- [Manual Testfit process meeting recordings](#)
- [Saltmine block inventory](#)
- [Circulation calculation and layout planning \(in progress\)](#)
- [Circulation examples \(Figma\)](#)
- [Calculating adjacency matrix using Utilization and Spatial proximity data](#)
- Tools and methods:
 - [Rhino/Grasshopper \(DOTS\)](#)
- Competitor analysis
 - [Hybar](#)

Key Stakeholders

The following teams within Saltmine will be the key stakeholders for the above effort:

- Core
- Data Science
- Designer
- InterOP team
- Ops
- ST

Key Dependencies

This product depends on the ability to:

1. Select workstyles of each project.
2. Select the standards or regulations that govern each project.
3. The ability to automatically identify some spatial objects (core, shell, doors on the core, windows)
4. The ability to do basic spatial analysis such as :
 - a. Space syntax analysis
 - b. Spatial network analysis.
 - c. Proximity analysis

Key Dates/Timelines

	Sprint2	Sprint3	Sprint4	Sprint5	Sprint6	Sprint7	Sprint8	Sprint9
	Jan 30, ...	Feb 13, ...	Feb 27, ...	Mar 13, ...	Mar 27, ...	Apr 10, ...	Apr 24, ...	
Conceptualization								
Use Case scenarios								
User Flow / Wireframes								
Circulation Fitting (Jira)								
Logic and algorithm								
UI/UX mockups								
Backend								
Frontend								
QA and UAT								
Deploy to SIT								
Documentation								
Auto Zone Fitting (Jira)								
UI/UX mock ups								
Logic and algorithm res.								
Use case & Testcase								
Backend								
Frontend								
QA and UAT								
Deploy to SIT								
Documentation								
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UI/UX mock ups								
Logic and algorithm res.								
Use case & Testcase								
Backend								
Frontend								
QA and UAT								
Deploy to SIT								
Documentation								

Open Questions

- Specify any queries/ Suggestions

References

- Include references (@Google Slides/ Spreadsheets/ Docs) that we can refer for more context
-