UNIVERSITY OF
WEST LONDON

AI in Architecture .

Evaluating Current Tools & Advancing Prototype Development for School Building Design

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Major Research Focuses of ACUS

- Artificial Intelligent System for Educational Buildings
- Sun-lighting for school buildings during wintertime in England
- Digital-Twin System of Indoor Environmental Quality (IEQ) Monitoring and Controlling of Educational Buildings

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Approach

Qualitative, interpretivist research framework

Examining AI as a socio-technical system within architectural practice

- Focuses on design agency, not performance benchmarking
- Considers disciplinary values, workflows, and technological mediation
- Evaluates AI across the full project lifecycle

Methodology

Phase 1
Selection and Categorisation

Identification and classification of 50 AI Applications based on their roles within the project lifecycle

Phase 2
Mapping and Analysis

Comparative mapping of AI Logic and Architectural Values and understanding the role of the Design Agency

Secondary mapping against parameters like Building Typology, User Type, Geographic Context and Tool Maturity

Selected AI Tools

Distribution of AI Tools Across the Project Lifecycle

From an initial landscape of over 150 AI-based tools, a curated set of 50 tools was selected for detailed analysis; beyond this point, no new patterns of design agency redistribution emerged, indicating analytical saturation.

Each tool was mapped to the RIBA Plan of Work (Stages 1–5) based on its primary function within architectural workflows.

Selection Criteria for AI Tools

- Relevance to Architectural Practice
- AI-Based Functionality
- Non-Conceptual / In-Use Status

Stage 1 Preparation and Briefing	Stage 2 Concept Design	Stage 3 Spatial Coordination	Stage 4 Technical Design	Stage 5 Manufacturing & Construction
AECOM PlanEngage	Architechtures	Augmenta	Alice Technologies	AI-SpaceFactory
ARKdesign.ai	ArkAI	BricsCAD BIM AI	CityEngine	AirWorks
Archistar	Autodesk Forma	NeuralConcept	Ecopilot	Avvir
Delve	Chaos Veras	Preoptima	Generative AIBIM	Buildots
Orkestra	Cove.tool	QBiq AI	Tally	Deep Space
UrbanForm	Finch3D	Revit (AI plugins)		Disperse
Urbanist AI	GroundUp	Rhino (AI plugins)		Doxel
iPLAN	Hypar	Swapp		Imerso
	LookX	UpCodes AI		OpenSpace.ai
	Maket.ai			SiteAware
	Midjourney			Verisk AI
	MNML			
	Rerender			
	Spacemaker			
	Spacio			
	Stable Diffusion			
	TestFit			

The Construct

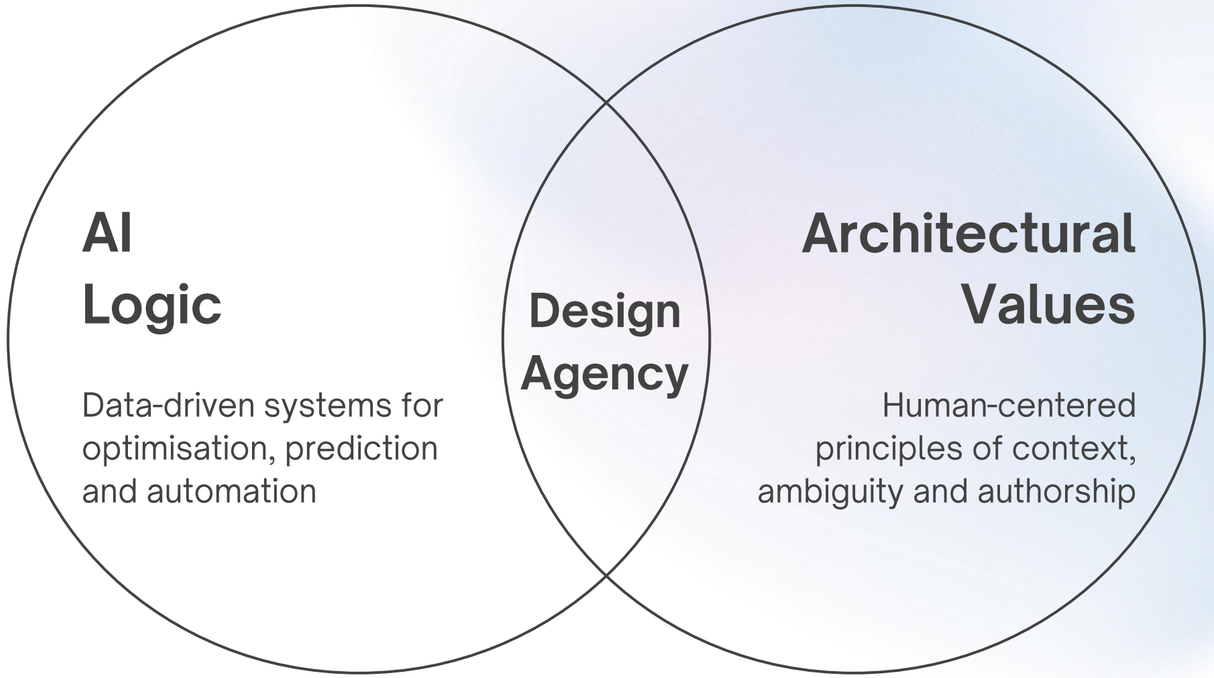
AI Logic, Architectural Values, & Design Agency

AI LOGIC (AL)
The degree to which the tool embodies computational reasoning, automated intelligence, and data-driven decision-making.

What it captures:
How "intelligent" and self-directed is the tool?
Does it optimise complex problems, can it learn from data??

ARCHITECTURAL VALUES (AV)
The extent to which the tool supports qualitative, human-centered design dimensions central to architectural practice: creative authorship, contextual responsiveness, and exploratory thinking.

What it captures:
Does the tool preserve architect control and creativity?
Does it respond to local context or apply generic solutions?



The shifting balance of creative control between architects and AI

DESIGN AGENCY

Emerges at the intersection of AI Logic and Architectural Values, redistributing decision-making between humans and AI systems.

Design agency is defined here as who controls key spatial, contextual, and value-laden decisions across the project lifecycle.

Pilot Study

10 Expert Raters

- Ten expert panel members shortlisted and invited to participate in a 30-minute evaluation session
- Each expert provided independent assessments to ensure balanced and credible scoring.

5 AI Applications

- Five AI applications were chosen, representing different stages across the project lifecycle
- Ensuring a comprehensive evaluation of AI usage throughout project development and delivery.

Rated on AL and AV

- Each application was rated on two dimensions, Architectural Values and AI Logic,
- 1 to 10 scoring scale used, enabling consistent comparison of design quality and AI capability.

Scoring Framework

AI Logic & Architectural Values

The scoring is interpretive rather than performance-based, and is intended to position tools relatively, not rank them. This approach makes visible how design agency is redistributed between human designers and AI systems across different stages of the project lifecycle.

01 Low (0-3)

AI Logic

- Tool functions as assistive interface
- Required continuous human input
- Minimal Automation

Architectural Value

- Outputs are narrowly technical
- Focused on compliance
- Little scope for designer interpretation

02 Medium (3.25 - 6.75)

AI Logic

- Tool only partially automates task
- Provides optimisations without full autonomy

Architectural Value

- Tool allows some contextual adjustments
- Remains largely bound by technical parameters only

03 High (7 – 10)

AI Logic

- Tool automates complex processes independently
- Significantly reduces manual interventions

Architectural Value

- Tool explicitly supports design agency
- Is open-ended and integrates context
- Preserves creative authorship by allowing inclusion in the process

Assigned Scores

AI Logic & Architectural Values

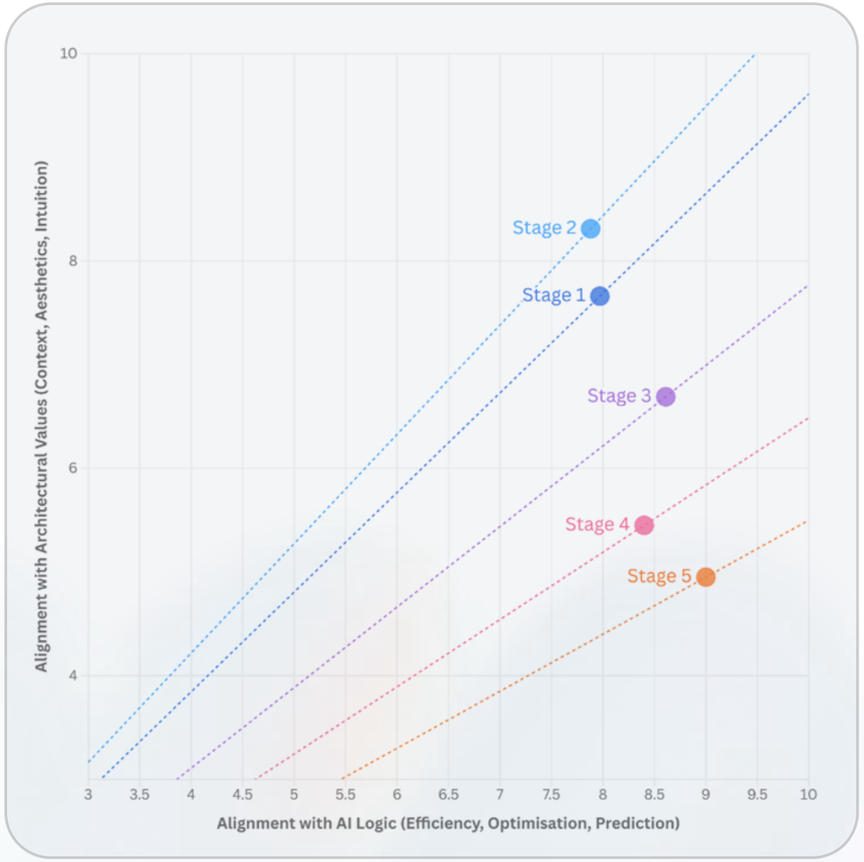
Scores for AI Logic (AL) and Architectural Value (AV) were assigned using a qualitative rubric based on each tool's mode of operation, degree of automation, and impact on architectural decision-making across project stages.

The scoring is comparative and interpretive, intended to reveal relative tendencies rather than absolute performance or accuracy.

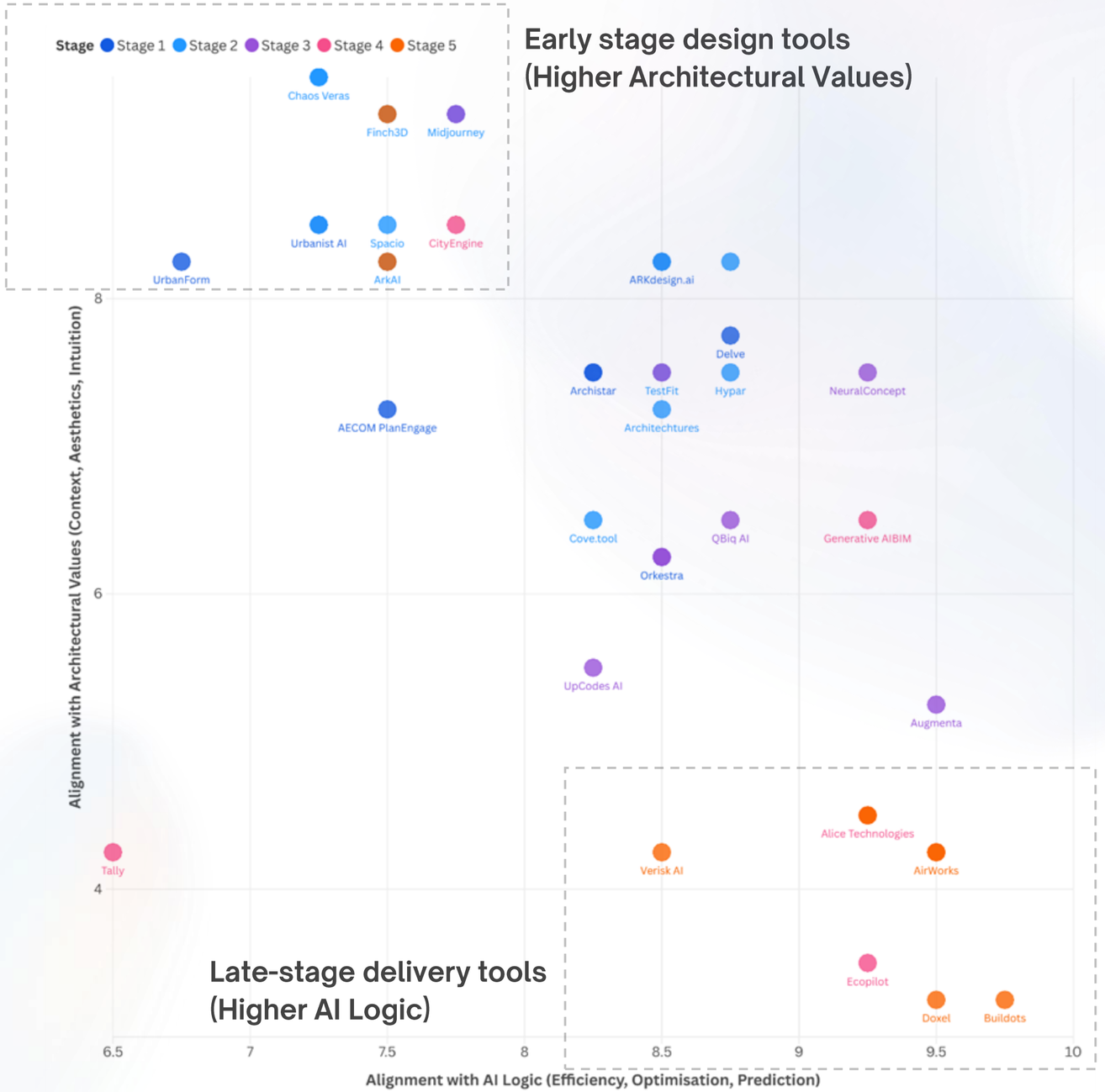
Stage 1			Stage 2			Stage 3			Stage 4			Stage 5		
Tool Name	AL	AV	Tool Name	AL	AV	Tool Name	AL	AV	Tool Name	AL	AV	Tool Name	AL	AV
AECOM PlanEngage	7.5	7.25	Architechtures	8.5	7.25	Augmenta	9.5	5.25	Alice Technologies	9.25	4.5	AI-SpaceFactory	7.5	9.25
ARKdesign.ai	8.5	8.25	ArkAI	7.5	8.25	BricsCAD BIM AI	8.5	6.25	CityEngine	7.75	8.5	AirWorks	9.5	4.25
Archistar	8.25	7.5	Autocad Forma	8.75	8.25	NeuralConcept	9.25	7.5	Ecopilot	9.25	3.5	Avvir	9.25	4.5
Delve	8.75	7.75	Chaos Veras	7.25	9.5	Preoptima	8.5	6.25	Generative AIBIM	9.25	6.5	Buildots	9.75	3.25
Orkestra	8.5	6.25	Cove.tool	8.25	6.5	QBiq AI	8.75	6.5	Tally	6.5	4.25	Deep Space	7.5	8.25
UrbanForm	6.75	8.25	Finch3D	7.5	9.25	Revit (AI plugins)	8.5	7.5				Disperse	9.25	4.5
Urbanist AI	7.25	8.5	GroundUp	8.5	6.25	Rhino AI plugins	7.75	9.25				Doxel	9.5	3.25
iPLAN	8.25	7.5	Hypar	8.75	7.5	Swapp	8.5	6.25				Imerso	9.5	4.25
			LookX	7.5	9.25	UpCodes AI	8.25	5.5				OpenSpace.ai	9.25	4.5
			Maket.ai	7.25	8.5							SiteAware	9.5	4.25
			Midjourney	7.75	9.25							Verisk AI	8.5	4.25
			MNML	7.5	8.25									
			Rerender	7.25	9.5									
			Spacemaker	8.5	8.25									
			Spacio	7.5	8.5									
			Stable Diffusion	7.25	9.5									
			TestFit	8.5	7.5									

Mapping AI Tools

Against AI Logic & Architectural Values



Average positions of AI tools by lifecycle stage, showing higher Architectural Values in early stages and stronger AI Logic in later stages.



Design Agency

Redistribution Across the Project Lifecycle

Early Integration (Stages 1–2):

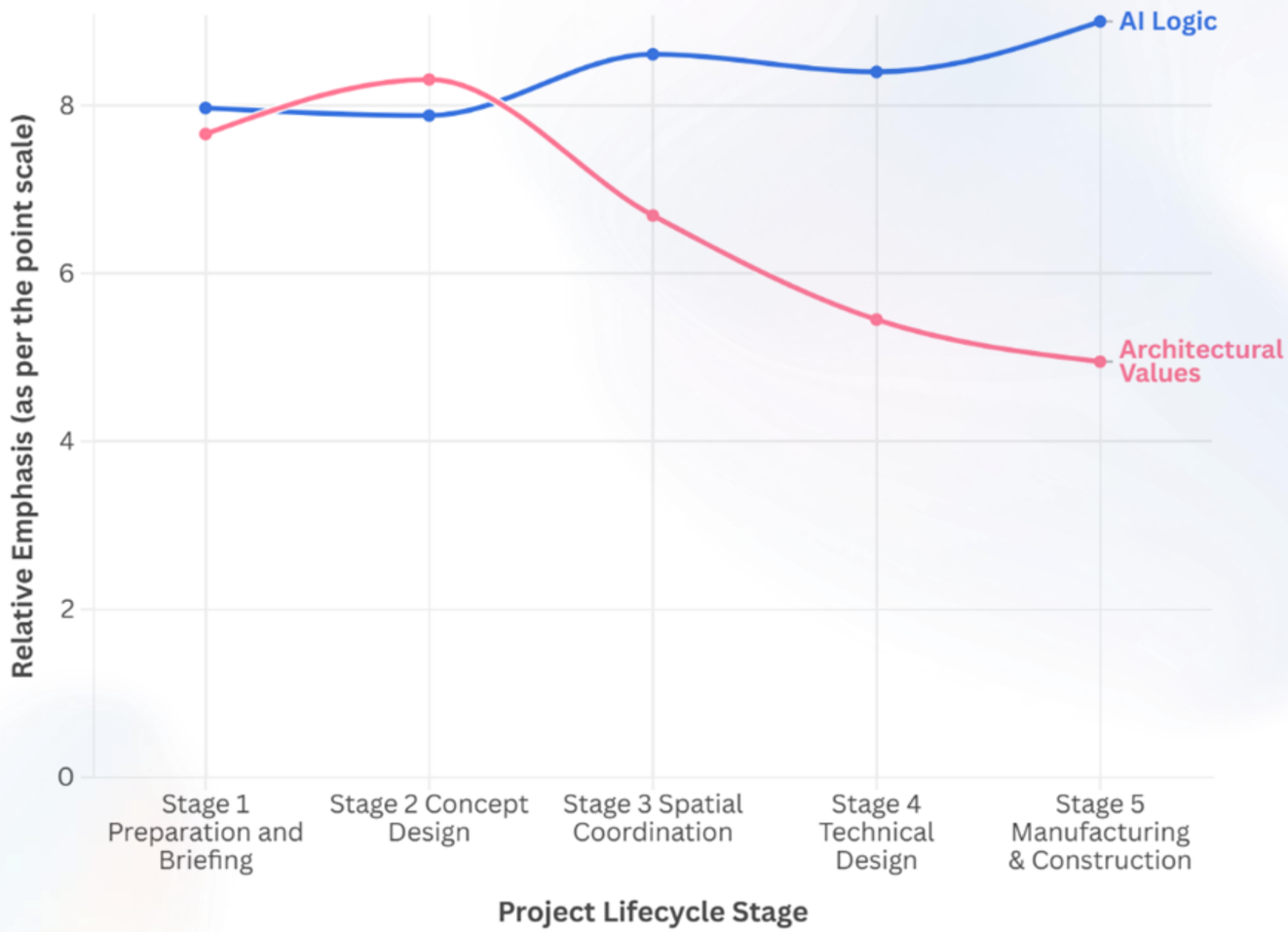
- Both AI Logic and Architectural Values remain strong
- Tools used here support design exploration and context-setting, keeping human agency central to the process

The Divergence (Stage 3 Onward):

- AI Logic becomes dominant as it automates coordination, technical design, and construction.
- Conversely, Architectural Values decline, with emphasis shifting away from cultural interpretation toward efficiency and technical delivery.

This trend highlights a redistribution of agency early creativity gives way to later automation.

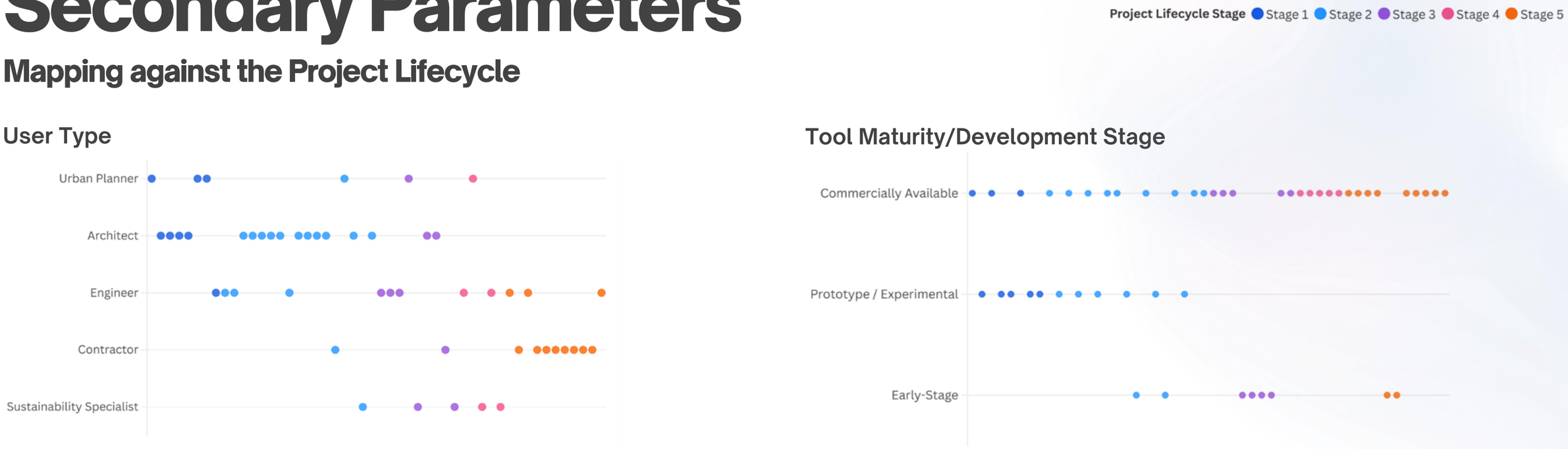
The widening gap between the two curves illustrates the tension between human-driven design intent and AI-driven optimization across the lifecycle.



Redistribution of design agency across the lifecycle, with AI Logic increasing and Architectural Values declining from early design to construction

Secondary Parameters

Mapping against the Project Lifecycle

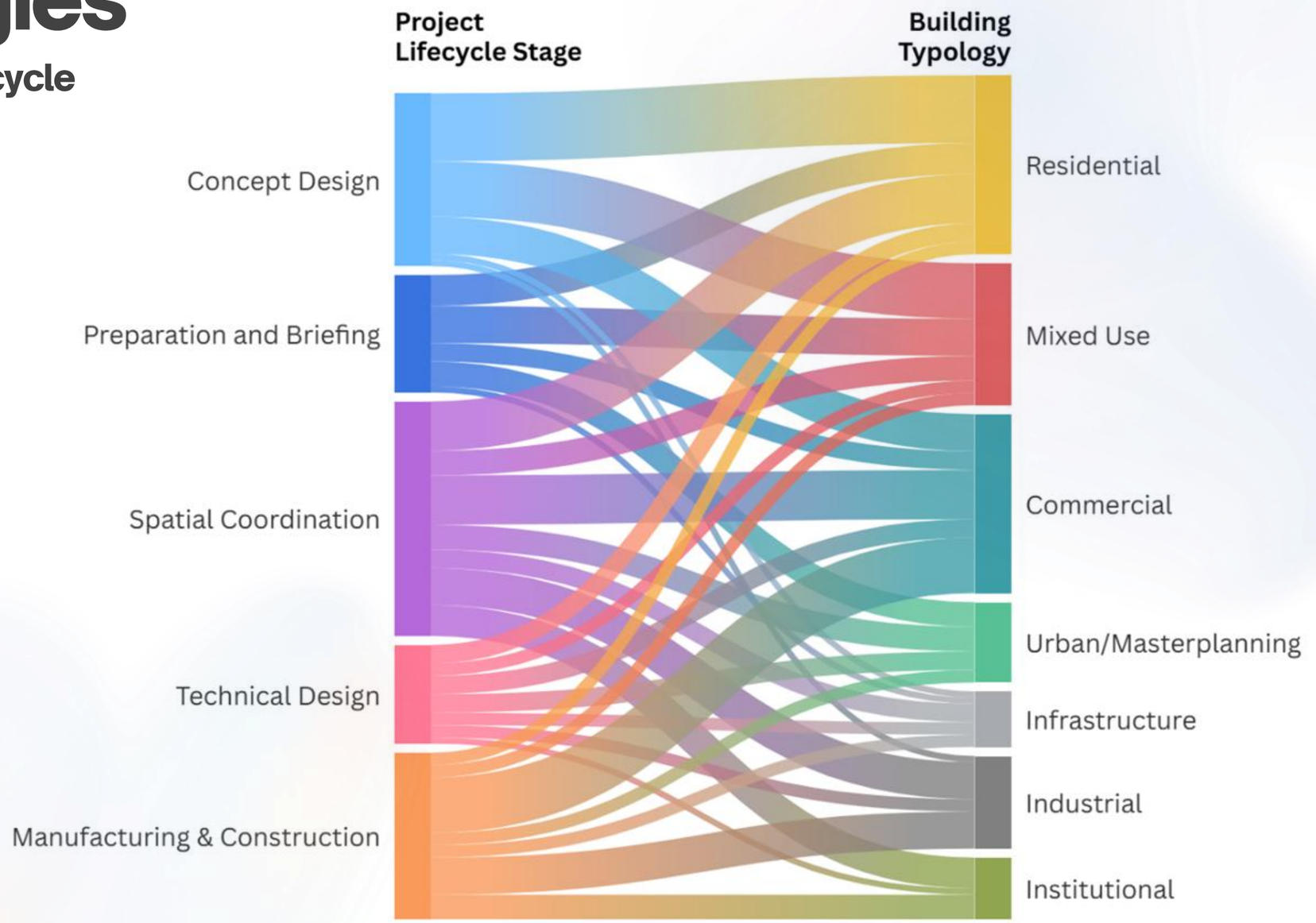


Building Typologies

Redistribution Across the Project Lifecycle

Mappings reveal that AI adoption in architecture is unevenly distributed across building typologies, user groups, and geographic contexts.

- Residential and commercial projects show the strongest uptake
- Institutional and infrastructure typologies remain underrepresented, particularly in early design phases.



Findings

01

DESIGN PRACTICE

- Redistribution of Design Agency
- Lifecycle gradient of AI Influence

02

TECHNOLOGY LANDSCAPE

- Structural Bias in Tools
- Gap in high-AI logic / high- Architecture value tools

03

INDUSTRY & GOVERNANCE

- Market and Regulatory Drivers
- Underrepresentation of Institutional & Sustainability Tools

Identifying the GAP

Institutional Architecture

Input Data

For School Building Design

The secondary mappings reveal a consistent gap in AI tool support for institutional building typologies, particularly durin early planning and concept design stages.

These projects are characterised by;

- High adjacency requirements
- Hierarchical spatial organisation
- Strict regulatory constraints

Despite this, existing AI tools primarily address either early stage creative exploration in market-driven typologies or late-stage optimisation and construction efficiency.

SCHEDULE OF ACCOMMODATION TOOL FOR ANY MAINSTREAM PRIMARY SCHOOL — Version 8.3 November 2023

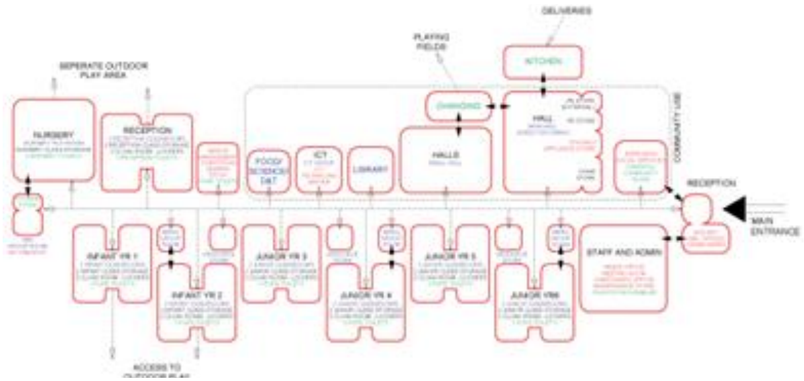
age range 3-11 | school name [Insert Project Code and Scheme Name here in title sheet] | date | as a check, if new:

2 FE classes of 30 | 13

		classes	2023 net capacity	site: sufficient	no. of blocks: 1	net capacity for recommended
reception places	60	2	for SoA below = 420		number of storeys: 2-storey	SoA below: 420
infant places	120	4	within a potential range of:		existing buildings to be: some retained	
junior places	240	8				
age 3 - 4 nursery places	26 FTE	14	397 to 442			378 to 420
Total Mainstream Places	446	420	4 to 11 places		1 float if rec'd net — not over rec'd gross	
Additionally resourced FTE places for:					organisation options for:	
-		0			infant: all practical in classrooms	
- SEN					junior: specialist practical spaces	

Final ADS Code	Space type	existing or new (new if blank)	max. group size	average area of space (m²)	TOTAL no. of spaces	TOTAL AREA (m²)	NON-NET AREA (m²)	SUPP AREA (m²)	AREA OF RE-TAINED SPACES		recommended area of space (m²)	recommended no. of spaces (& total supp area)
	Basic Teaching Area											
	Classrooms or classbases/ shared teaching				(15)							
	-											
PRI03	Nursery playrooms		27	55	1	55				54 m2 or 2.3m2 per place min recom'd	55	1
PRI13	Reception classrooms		30	62	2	124				62 m2 minimum recommended	62	2
PRI25	Infant classrooms (extensive)		30	62	4	248				62 m2 minimum recommended	62	4
	-											
PRI33	Junior classrooms		30	55	8	440				55 m2 minimum recommended	55	8
	-											
	Specialist practical/ other				(1)							
PRA12	Primary practical (food/ science/ DT)		34	69	1	69					69	1
PRA16	Primary practical (art/ DT)											
	-											
	TOTAL AREA BB103 range 900 to 1020					936				OK: area within BB103 range	936	
	Large spaces: halls, studios and dining									dining options: 40 mins all in main hall		
HAL13	Assembly halls, primary (assembly max)		270	150	1	150				144 m² min recom'd for all pupils dining	150	1
PER11	Music and drama classrooms, studio		30	55							55	
HAL12	Activity studios (small hall)		30	85	1	85					85	1

Schedule of Accommodation (SOA)

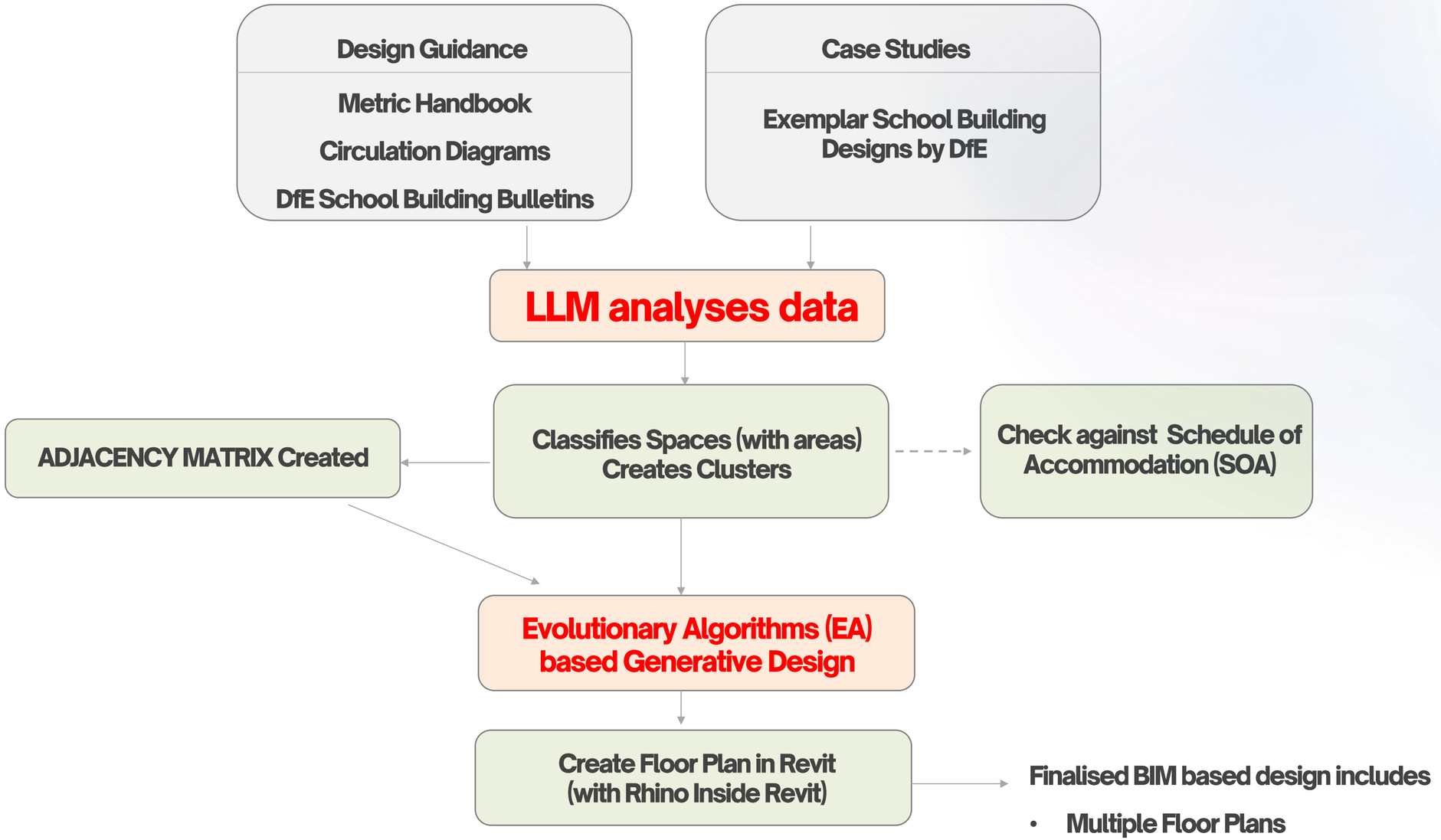


Building Bulletin Plans for School Buildings along with Circulation Diagrams

Framework

School Design Project

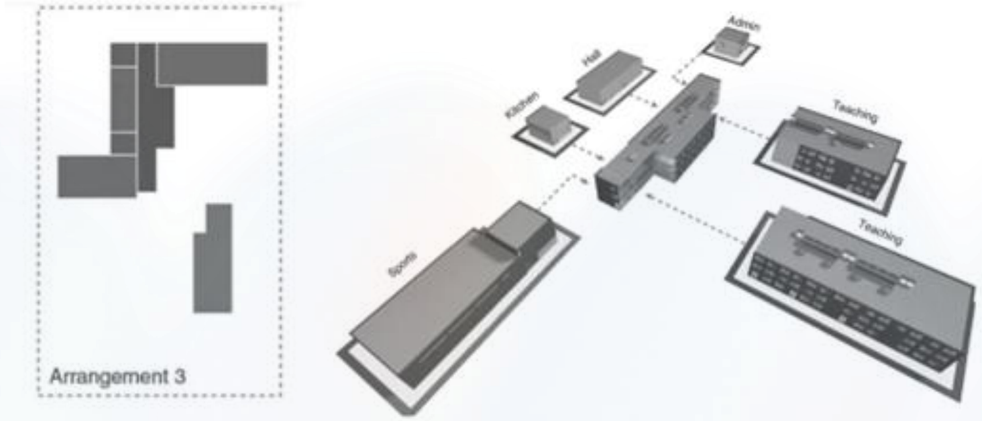
(Input information - Type of Project, No of Pupils, Site details)



Adjacency Matrix – Manual Intervention

Encoding Spatial Relationships & Hierarchies

- Creation of Room Databases and Clusters
- Each cluster in turn comprises of multiple rooms clubbed together
- Adjacencies formed between clusters for optimal optioneering outputs



	Nursery Learning Unit	Reception Learning Unit	Infant Learning Unit	Junior Learning Unit	Specialist Teaching Type 1	Specialist Teaching Type 2	Music & Drama Unit	Hall & Performance Type 1	Hall & Performance Type 2	Library & Resource Unit	SEN & Medical Support Unit	Admin Hub Type 1	Admin Hub Type 2	Admin Circulation & Access Point	Circulation Corridor	Dining & Kitchen Unit	General & Furniture Stores Unit	Reception & Infant Support Unit	Extra Early Years Support Unit	Overflow Junior Toilet & Store Node
Nursery Learning Unit	2	6	0	0	0	0	6	0	0	0	4	0	0	3	1	0	0	6	2	0
Reception Learning Unit		2	6	6	6	6	0	0	0	0	4	0	0	3	1	0	0	2	0	0
Infant Learning Unit			2	6	6	6	0	0	0	0	0	0	0	0	1	0	0	2	0	0
Junior Learning Unit				2	6	6	0	0	0	0	0	0	0	0	1	0	0	2	0	2
Specialist Teaching Type 1					2	4	4	4	4	4	0	0	0	0	1	0	0	0	0	0
Specialist Teaching Type 2						2	4	4	4	4	0	0	0	0	1	0	0	0	0	0
Music & Drama Unit							2	4	4	4	0	0	0	0	1	4	4	0	0	0
Hall & Performance Type 1								2	4	4	0	0	0	0	1	4	4	0	0	0
Hall & Performance Type 2									2	4	0	0	0	0	1	4	4	0	0	0
Library & Resource Unit										2	0	0	0	0	1	4	4	0	0	0
SEN & Medical Support Unit											2	4	4	4	1	0	0	0	0	0
Admin Hub Type 1												2	4	4	1	0	0	0	0	0
Admin Hub Type 2													2	4	1	0	0	0	0	0
Admin Circulation & Access Point														2	1	0	0	0	0	0
Circulation Corridor															2	1	1	1	1	1
Dining & Kitchen Unit																2	4	0	0	0
General & Furniture Stores Unit																	2	0	0	0
Reception & Infant Support Unit																		2	0	0
Extra Early Years Support Unit																			2	0
Overflow Junior Toilet & Store Node																				2

Current Iteration of the Adjacency Matrix with 20 clustered spaces establishing the connections between each of the clusters

Output from LLMs

		Nursery Learning Unit	Reception Learning Unit	EY Shared Cloaks & WC	Infant Learning Unit	Junior Learning Unit	Junior SEN & Small Group Unit	Specialist Teaching Type 1 (Studio)	Specialist Teaching Type 2 (Practica	Library & Resource Unit	SEN & Medical Support Unit (KS1)	Hall & Performance Unit	PE & Furniture Stores Unit	Dining & Kitchen Unit	Admin Hub - Front of House	Admin Hub - Back Office	Staff Support Unit	Welfare & Accessible Support Unit	Circulation Corridor & Vertical Acces	General & Furniture Stores Unit
1	Nursery Learning Unit	E	D	E										X			D	D	E	X
2	Reception Learning Unit		E	E													D	D	E	X
3	EY Shared Cloaks & WC			E														D	E	
4	Infant Learning Unit				E					D								D	E	D
5	Junior Learning Unit					E	D	D	D	D								E	E	D
6	Junior SEN & Small Group Unit						E	D	D									D	E	
7	Specialist Teaching Type 1 (Studio)							E	E									D	E	
8	Specialist Teaching Type 2 (Practical/Food Bay)								E									D	E	
9	Library & Resource Unit									E	D	E				D			E	X
10	SEN & Medical Support Unit (KS1)										E	X		X	E	D	E		E	
11	Hall & Performance Unit											E	E	E		X			E	
12	PE & Furniture Stores Unit												E						D	E
13	Dining & Kitchen Unit													E		X		X	D	E
14	Admin Hub - Front of House														E	E	D		E	
15	Admin Hub - Back Office															E	D	X	E	
16	Staff Support Unit																E	E	E	
17	Welfare & Accessible Support Unit																	E	E	D
18	Circulation Corridor & Vertical Access																		E	E
19	General & Furniture Stores Unit																			E

Legend

E	Essential - at least one room pair across these clusters must be directly adjacent. This includes: repeated instances of the same cluster (diagonal, e.g. multiple Nursery classrooms which must sit next to each other), and every room with a direct doorway onto the main circulation corridor.
D	Desirable - clusters benefit from proximity (same zone, or corridor-linked only indirectly via another room such as the Hall or Kitchen)
N	No specific requirement
X	Undesirable - contains a room pair that should be kept apart (noise/hygiene/security)
	Lower-triangle cells left blank (matrix is symmetric - see upper triangle only)

Prototype Development Framework

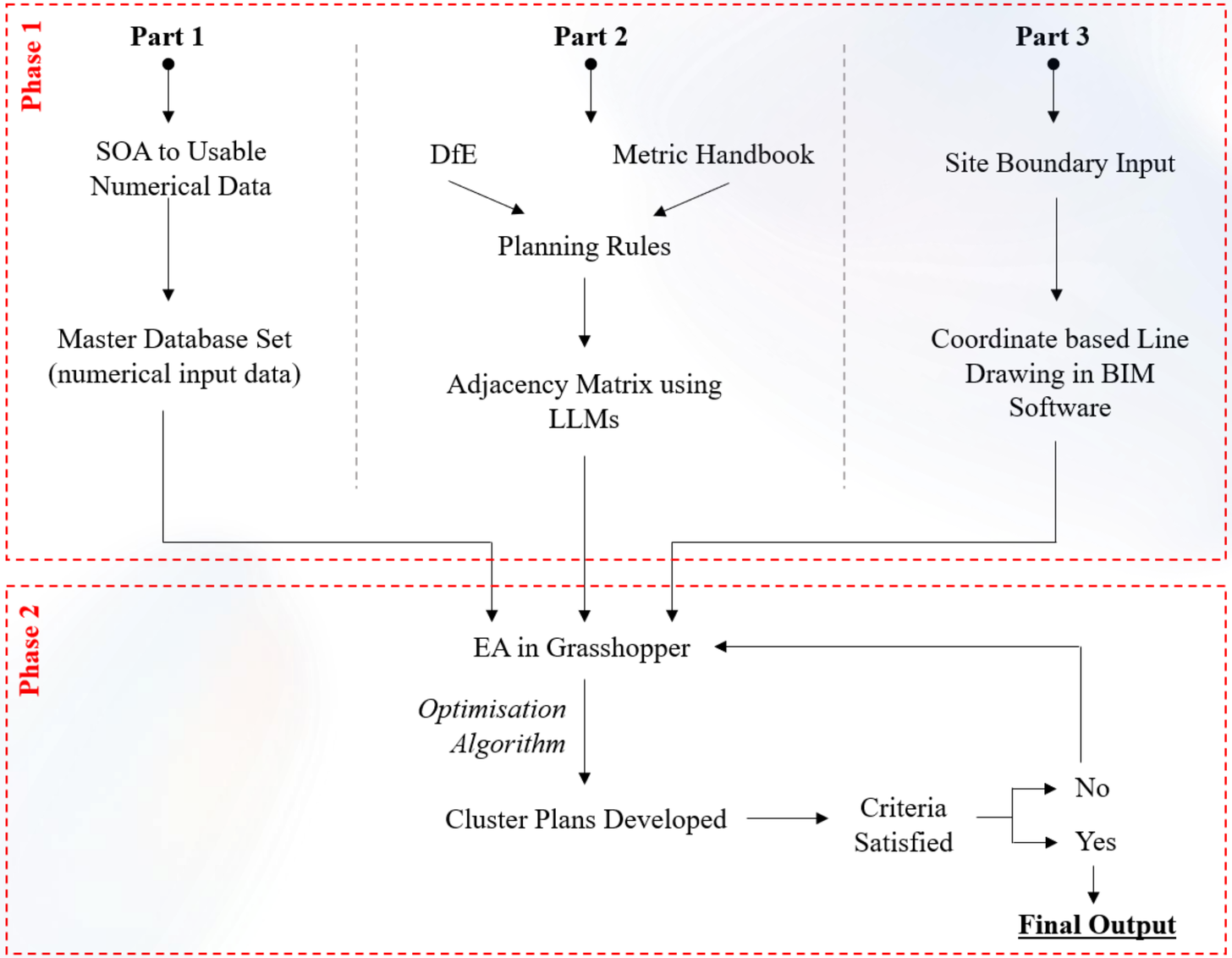
From Rules & Data to Spatial Proposals

Phase 1 · Structured Inputs

- Program & Rules
- SOA, DfE metrics, planning constraints
- Spatial Relationships
- Adjacency logic encoded as matrices
- Site Conditions
- Boundary geometry and orientation

Phase 2 · Generative Exploration

- Evolutionary algorithm explores multiple layouts
- Solutions evaluated against spatial and rule-based criteria
- Designers retain control over rules, priorities, and selection

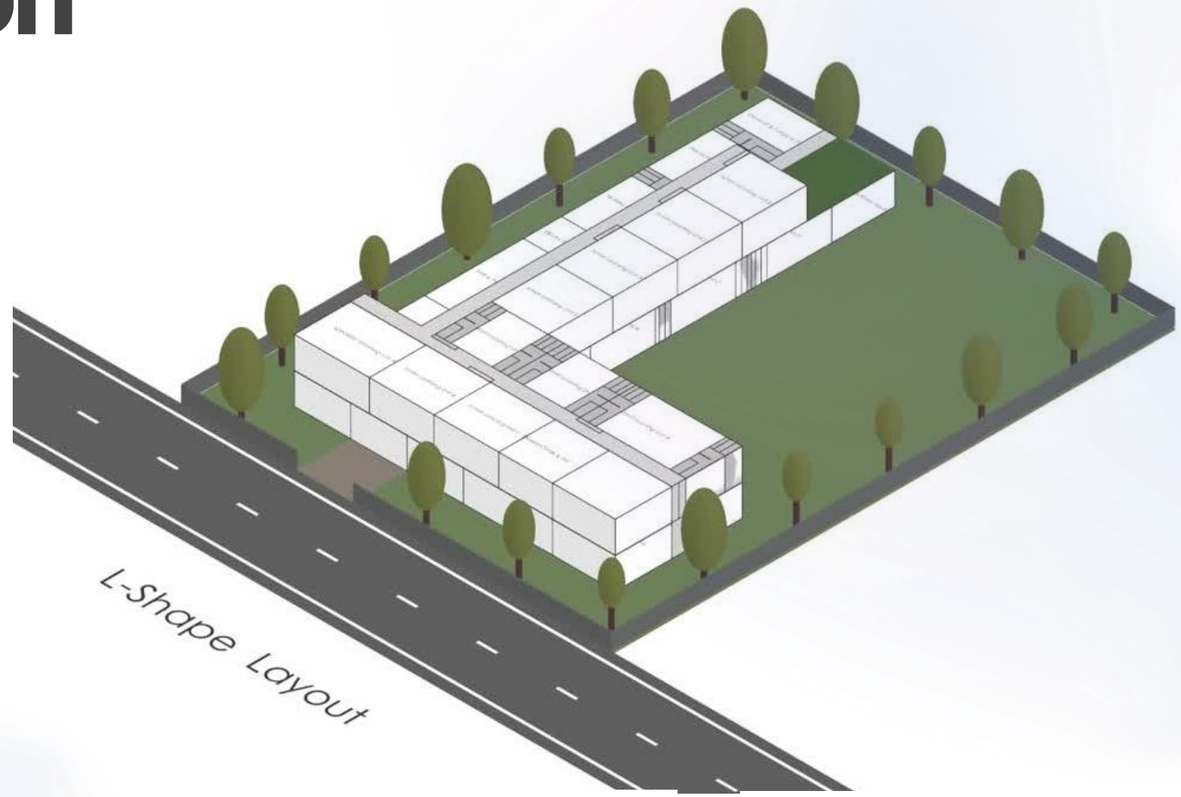


Plan Typology Exploration

Within Site Constraints

Defining the Design Search Space

- Site constraints and regulatory parameters establish fixed boundaries
- Plan typologies structure the range of permissible spatial configurations
- Multiple layouts are generated without privileging a single solution.



Linear Layout

Two Linear Blocks Layout

L - Shaped Layout

C - Shaped Layout

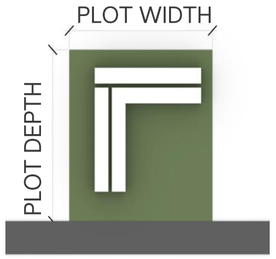
Square Layout

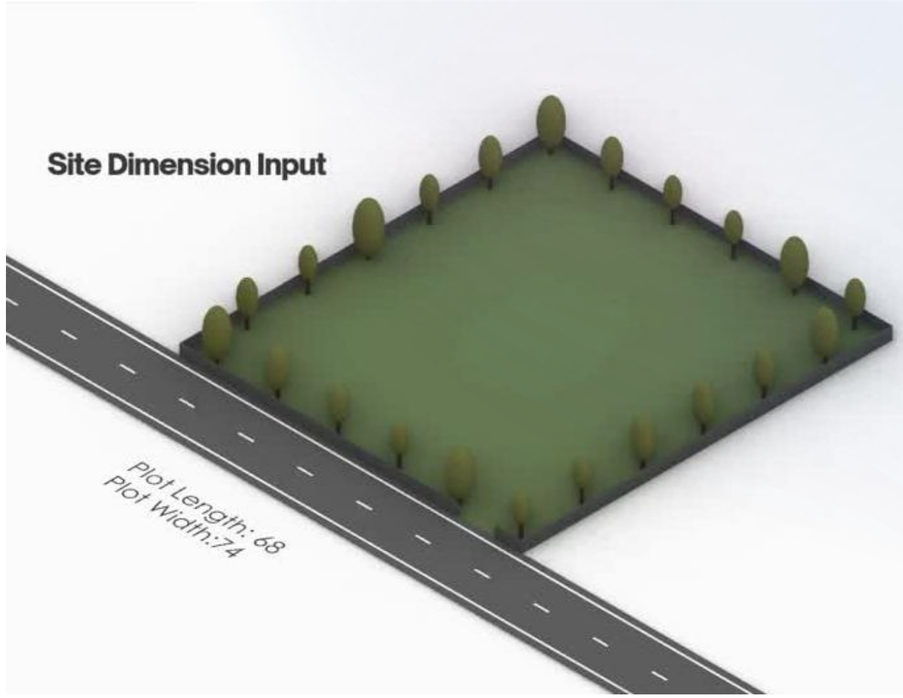
Input Parameters

Site & Configuration Parameters

Site Dimension

Defines plot width (X) and depth (Y)





Road Orientation

Identifies frontage edge for entrance placement.

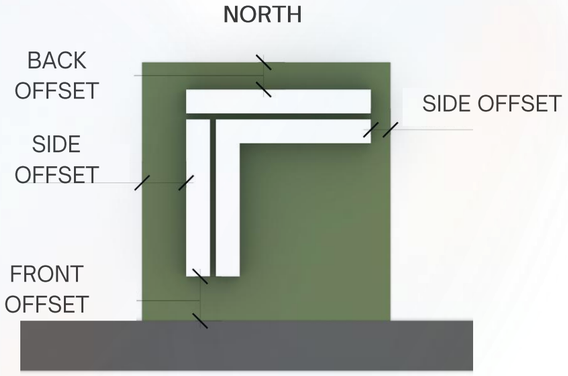
One Side Road | Two Side Road | Three Side Road

Orientation

Controls rotation of selected plan typology.

Setbacks on the site

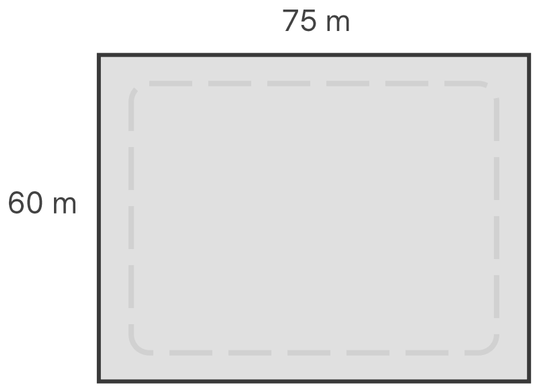
Applies regulatory offsets (front, side, rear).



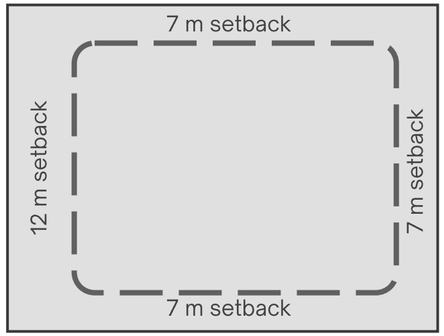
Case Study – Defining Parameters

Site & Configuration Parameters

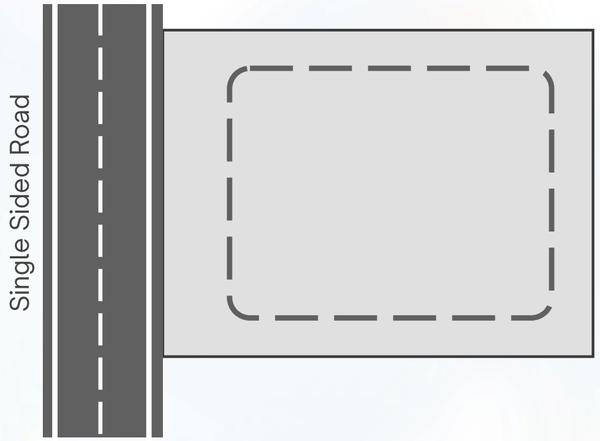
Site Dimensions



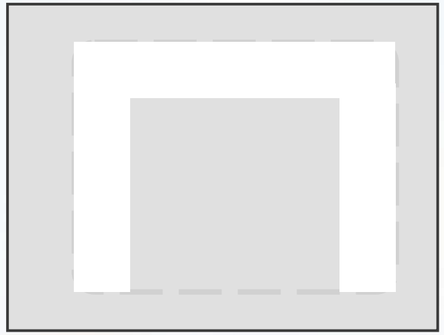
Regulatory Offsets



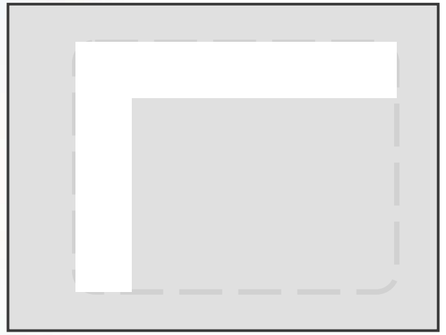
Road Condition



Selected Layout Typologies



C - Shaped Layout

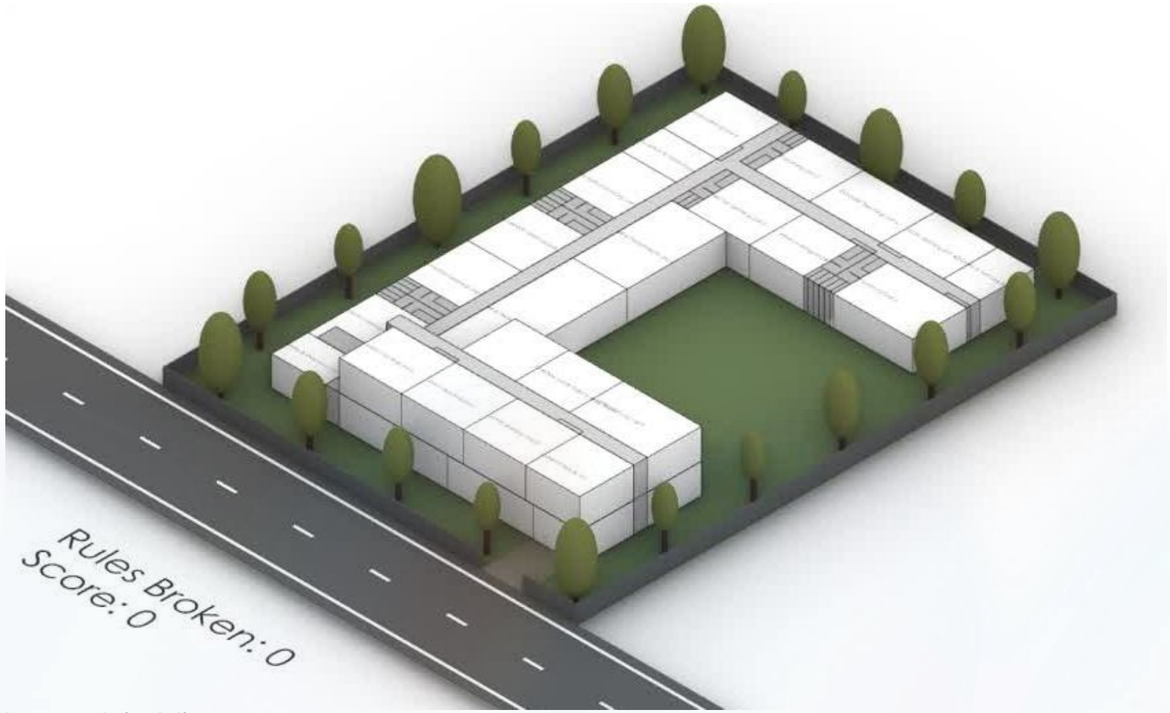


L - Shaped Layout

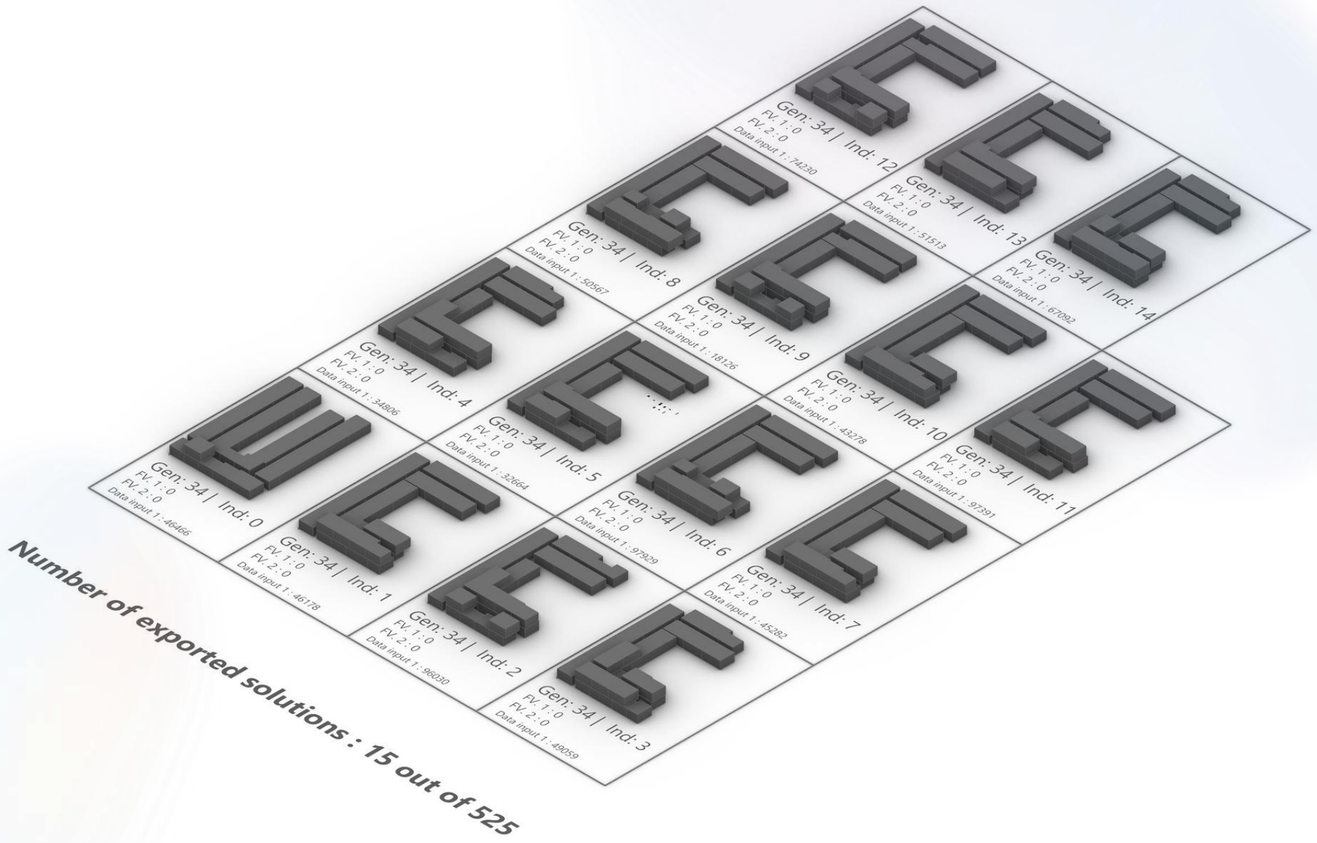
Clustered Space Programme Summary (Derived from SOA)	
Space / Unit	**Area (sqm)**
SEN & Medical Support Unit	356
Admin Hub Unit A	47
Admin Hub Unit B	82
Main staircase and lift core	30
Main entrance lobby	40
Specialist Teaching Unit A	69
Music & Drama Unit	55
Hall & Performance Unit A	159
Hall & Performance Unit B	91
Library & Resource Unit	35
Dining & Kitchen Unit	40
Nursery Learning Unit A	79
Reception & Infant Support Unit	39
Reception Learning Unit A	74
Infant Learning Unit A	665
Infant Learning Unit B	665
Junior Learning Unit A	595
Junior Learning Unit B	595
Junior Learning Unit C	595
Junior Learning Unit D	595
General & Furniture Stores Unit	15
Overflow Junior Toilet & Store Node	48
Shared Cloak & WC	39

Layout Generation

Automated Optimisation through Evolutionary Algorithm

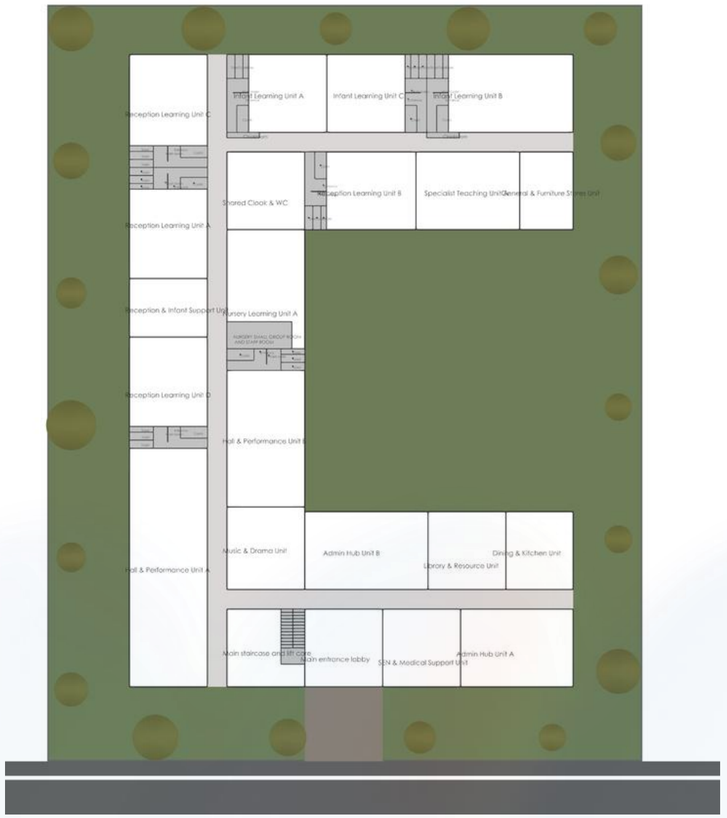


Isometric View

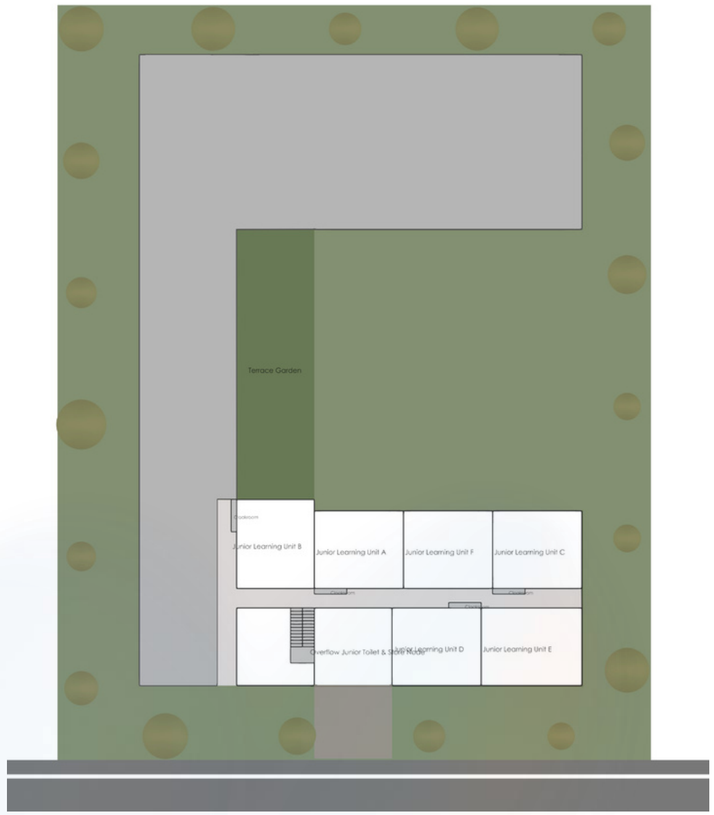


Optimised layouts

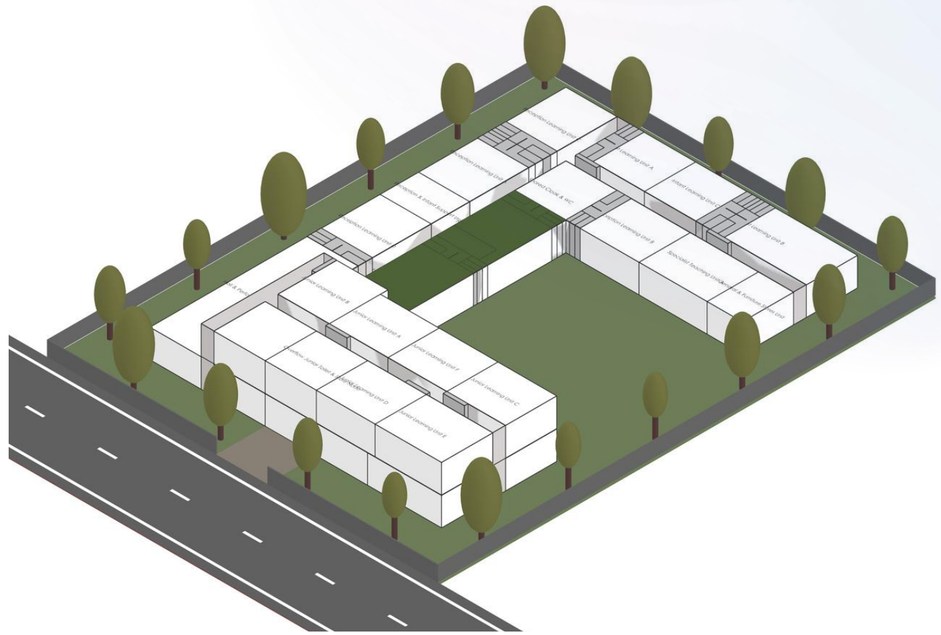
Automated Optimisation through Evolutionary Algorithm



Ground Floor Layout



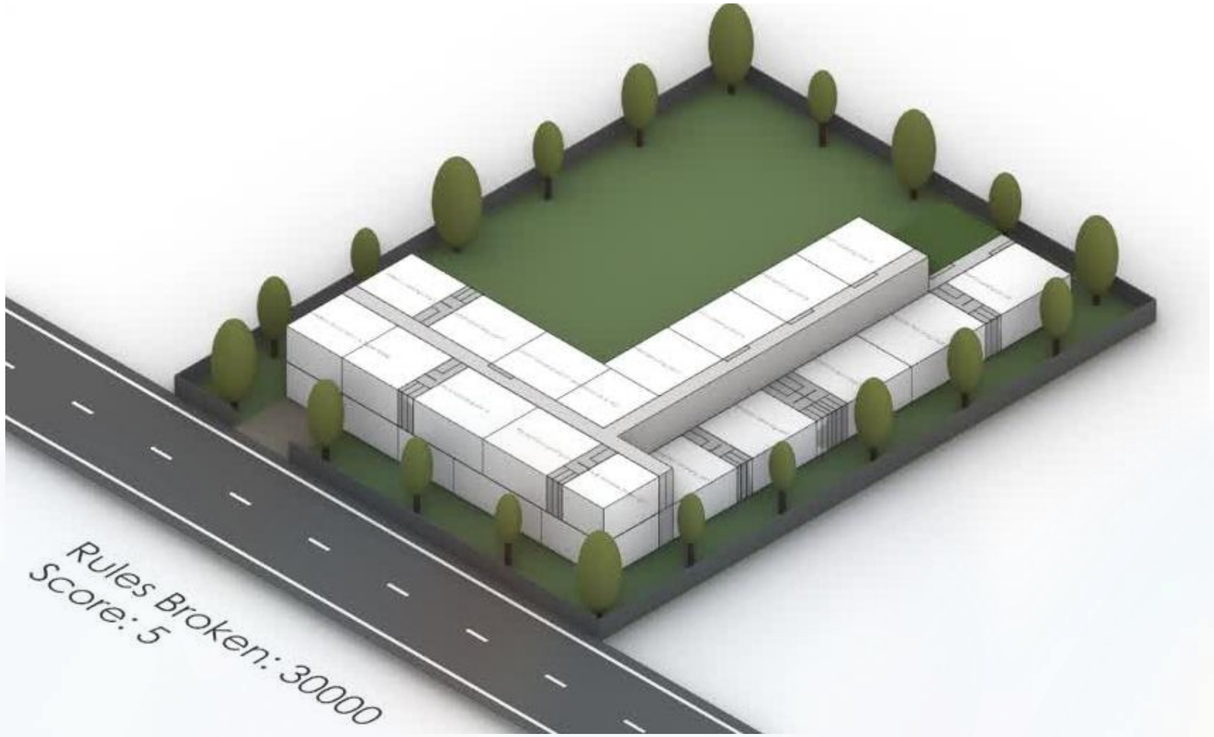
First Floor Layout



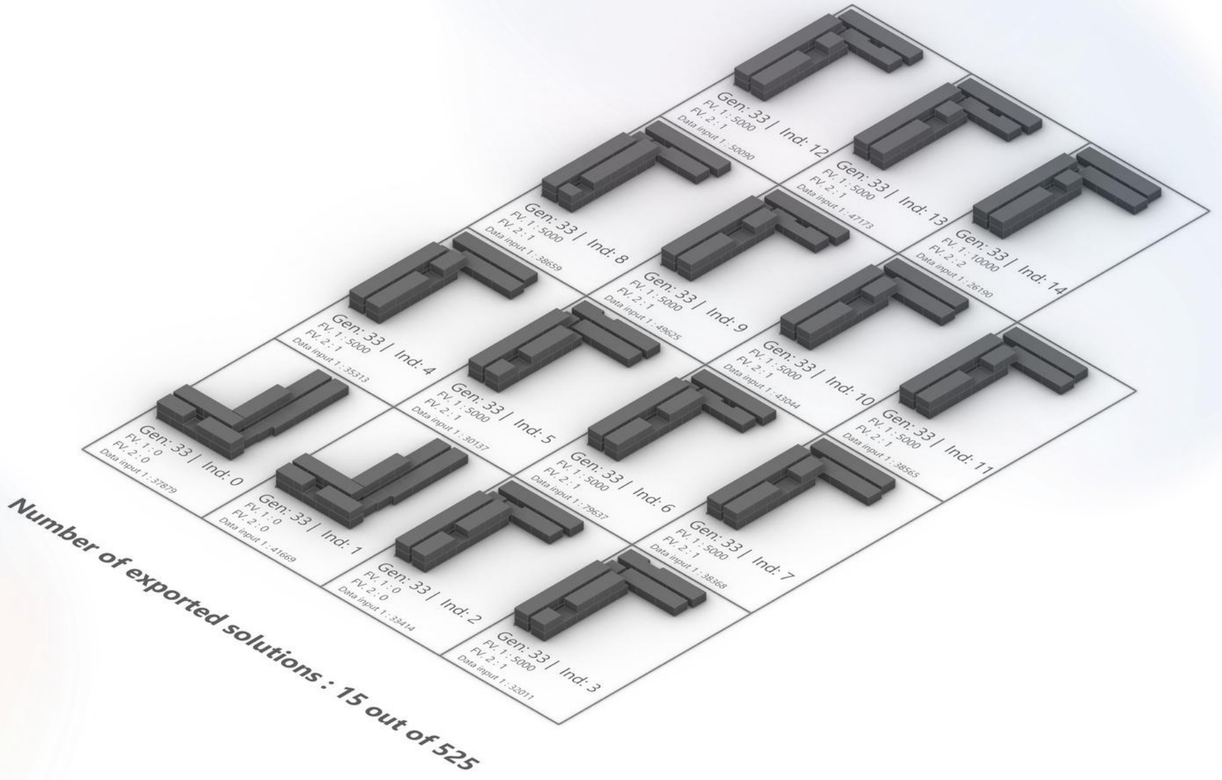
Isometric View

Layout Generation

Automated Optimisation through Evolutionary Algorithm

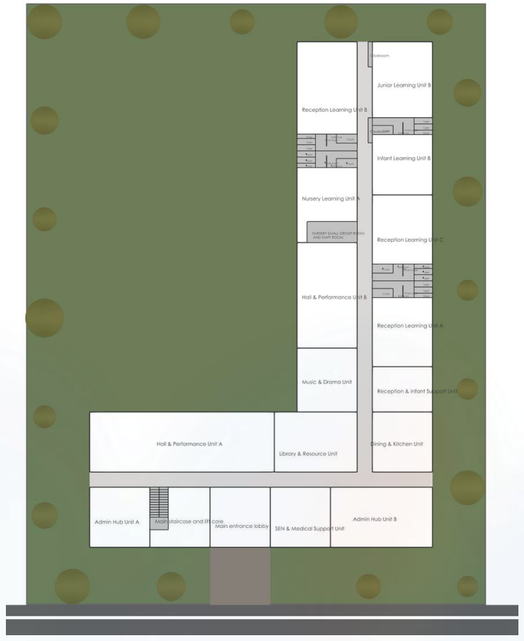


Isometric View

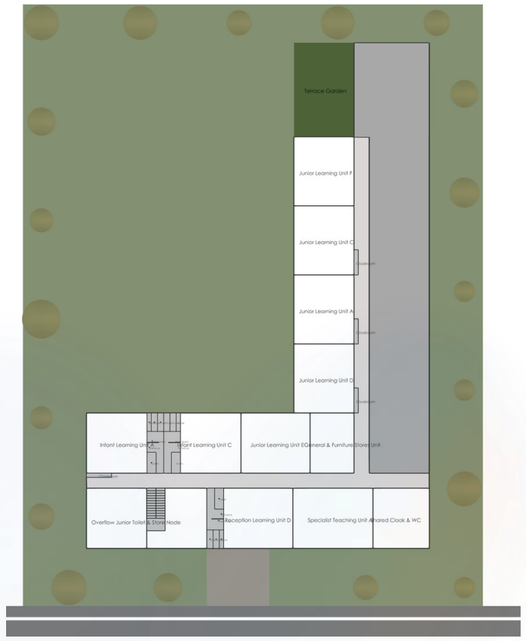


Optimised layouts

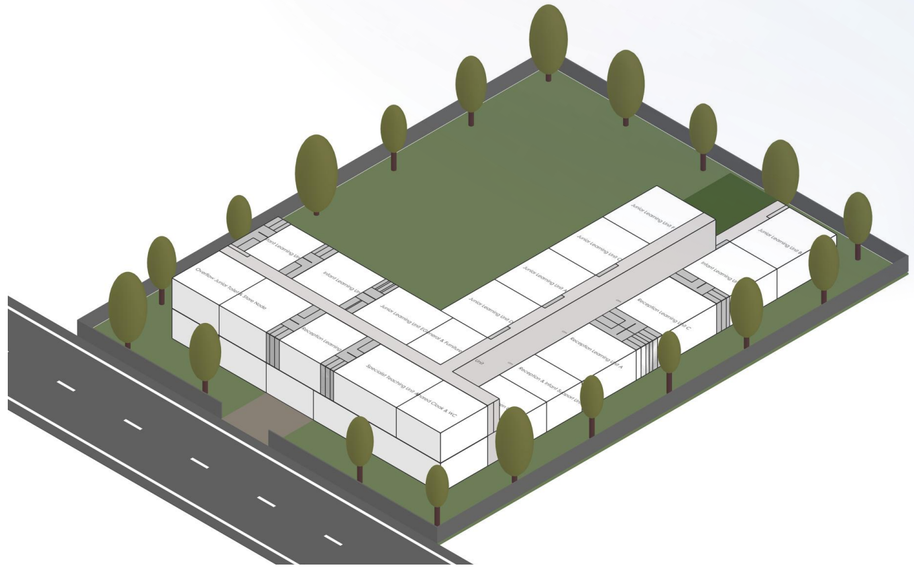
Automated Optimisation through Evolutionary Algorithm



Ground Floor Layout



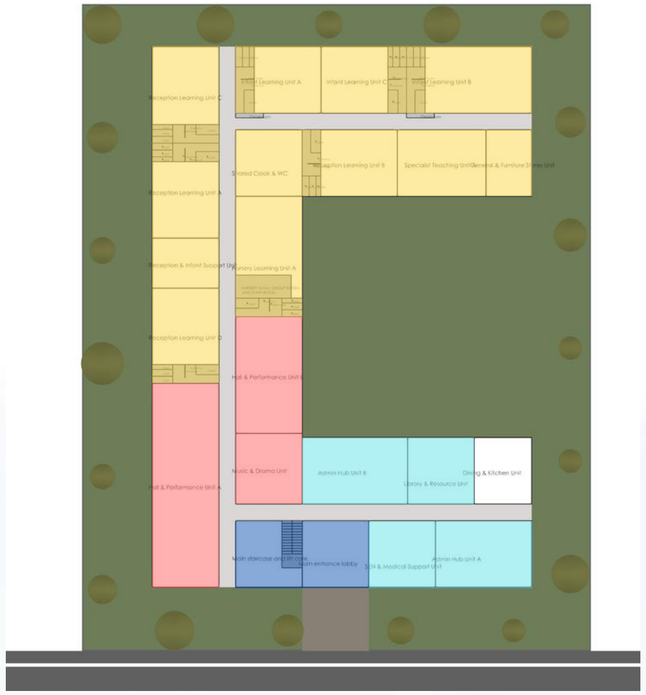
First Floor Layout



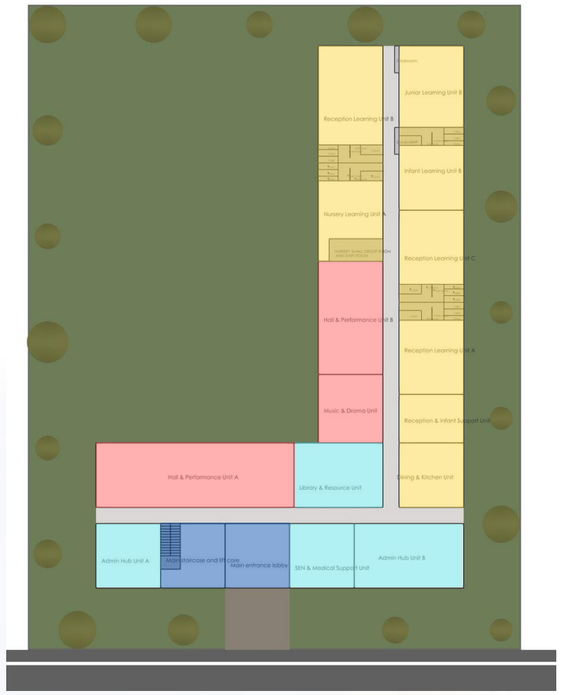
Isometric View

Comparative Analysis

Benchmarking Script-Generated Plans Against DfE Baseline School Designs



C - Shaped Layout



L - Shaped Layout

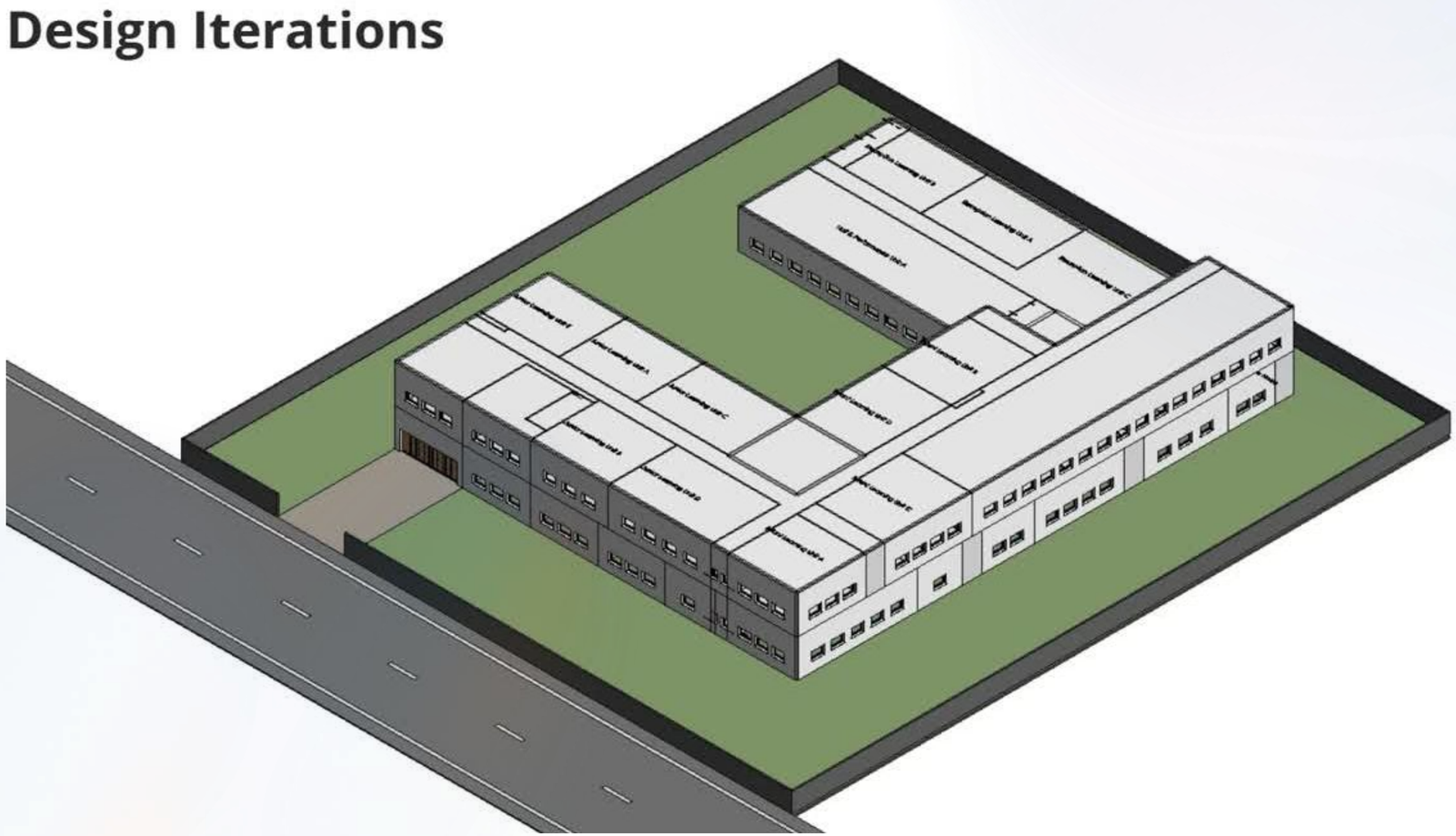
Baseline School Layout by Department for Education

Layout Evaluation and Optimisation

From Generative Layouts to BIM-Based Architectural Models

Spatial Integration

- Spatial systems consolidated into architectural elements
- Consistency and area checks applied before handover
- Outputs remain editable within standard BIM workflows



Generative layout translated into editable architectural elements

Thank You