Built to Scale: An Exploration Into Full Stack Development Strategies

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Full Stack Development Background

Developers refer to the technical levels of an application as a stack.

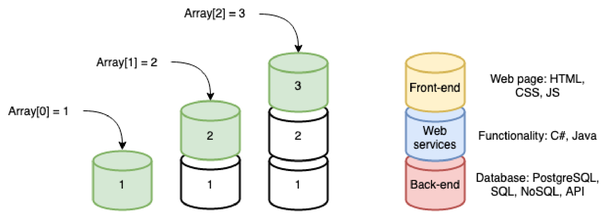

Figure 1. Programming stack vs. full stack methodology visualization to emphasise the resemblance and guide understanding.

At the very lowest level of the stack are the administrative tasks such as setting up user authentication, hardware, and basic infrastructure. The next level up from that includes all the back-end tasks like creating, querying, and maintaining databases, as well as implementing logic. The final level is known as front-end and involves designing, creating, and implementing UI/UX elements.

Back-end Design: Database Normalization

Databases are often a very complex aspect of full stack development, and thus the principles for designing databases focus on reducing data redundancy. The theory of database design is similar to a stack, where each guideline is dependent on the other and they build off what the past has formed. Following the format of a stack, iterating for a more concise database is known as normalization. [5] [3]

- **Normalization:** The process of structuring a database according to the normal forms in order to gradually reduce data redundancy.

The Abode application only deals with the first two normal forms and thus, only these principles and their influence on the design of the Abode database are talked about below. [6]

- **First Normal Form:** Eliminate divisible attributes. The previous design for this table had all of the information highlighted in red within one column. The first normal form suggests separating these attributes into individual columns to reduce redundancy.

Abode_Data				
Column 1 id	Column 2 college	Column 3 building	Column 4 room	...
1	Gilmour	Murphy	E24	...
2	Gilmour	Murphy	W22	...

Figure 2. The Abode database in first normal form. The previous design had the information highlighted in red within the same column.

- **Second Normal Form:** Separate purely informational attributes. Now each of the purely informational columns from the previous table are separated into their own table.

College			
Column 1 id	Column 2 name	Column 3 website	...
1	Gilmour	www.gilmour.org	...

Building			
Column 1 id	Column 2 name	Column 3 town	...
1	Murphy	Gates Mills	...

Room		
Column 1 id	Column 2 number	...
1	E24	...
2	W22	...

Figure 3. The Abode database in second normal form.

Mathematical Formulas for Normal Forms [5]

- The formula for the first normal form states that divisible attributes (A) should be separated into individual columns (B).

$$\{A\} \rightarrow \{B_1, ..., B_n\}$$

- The formula for the second normal form states that the newly informational attribute columns (B) should be separated into their own tables (C).

$$\{B_1, ..., B_k\} \rightarrow \{C\}$$

Back-end Design: Database UML

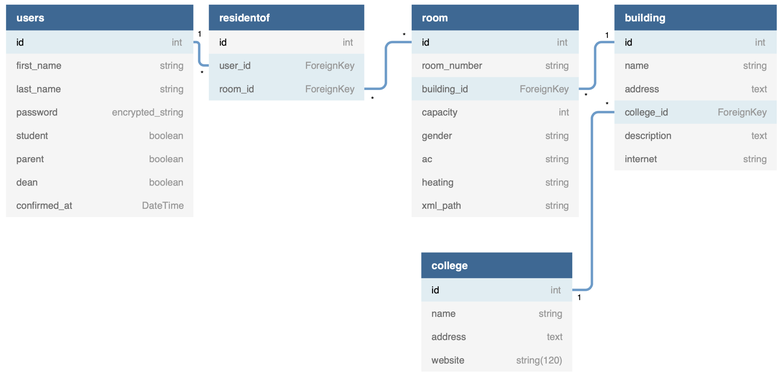

Figure 4. Representation of the Abode database classes and relationships.

UML diagrams are used to represent the relationship between our database classes. For example, the line drawn between the college and building tables can be read as "a college has multiple buildings." Where the original class inherits all of the information from the class it is associated with. This allows us to retrieve *any* data from *any* location on the diagram, ideal for database queries. [3] [2]

Front-end: UI/UX Theory and Principles

There are many facets of user interface design. The three theories below represent some of the most influential guiding principles for designing interfaces. I utilized these principles to design a product that is not only functional but is also very accessible for all users. [4] [1]

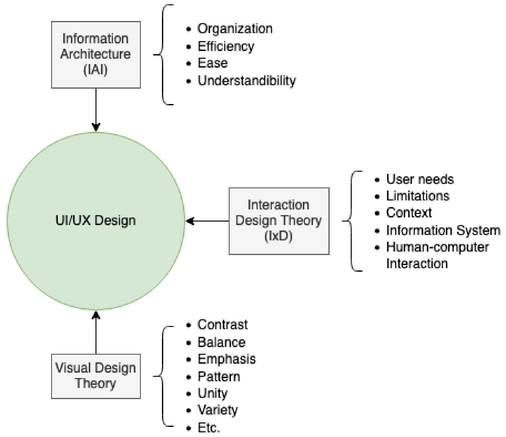

Figure 5. Simple diagram showcasing the components of UI/UX design.

- **Information Architecture:** The practice of deciding how to arrange the many parts of a product to be the most understandable, accessible, and useful. [4]
- **Interaction Design Theory:** The study of how to design products and services in such a way that the designers focus goes far beyond the product they are selling and straight into how users interact with it, hence the name. [4]
- **Visual Design Theory:** The guiding principles (rules) for designing a forward facing user interface. Helps designers in all aspects of UI create an aesthetically pleasing application. [1]

Front-end: 3D Model Generation

The first software, **Canvas** is an iPad attachment that scans rooms just as quickly as taking a video. The software is able to capture thousands of data metrics about the room in seconds, and results in a rough sketch, or formally known as a scan, of the desired room. The next software, Scan to CAD, is also provided by the Canvas services, and simply converts the resulting room scan into a CAD file manipulable by 3D editors like **SketchUp**. The third and final software, **Webrotate360**, allows these CAD files to be uploaded to a web application through the use of their API resulting in an interactive model.

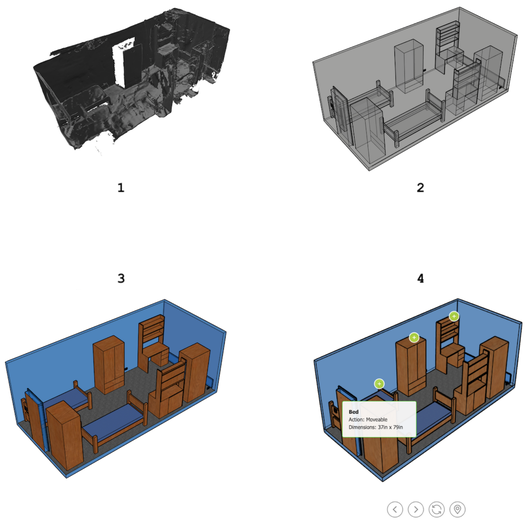

Figure 6. The process of converting a dorm room into a 3D model from start to finish.

- **[1] Canvas.io Laser Scanning (Scan to CAD)** In this first step the goal is to capture as much information about the space as possible. Canvas provides an iPad attachment that can capture the room layout in 3D resulting in the rough model you see above.
- **[2-3] SketchUp Editing Application** Once the scan converted into an editable model utilizing Scan to CAD, I color the most notable objects and prepared the model for imaging. The final step requires the model to be imaged in rotational steps.
- **[4] WebRotate360 Modeling Software** Taking those images, the WebRotate360 software creates rotating 3D model of the space. The green markers on the model provide more information, like dimensions, about specific objects.

References

[1] The essential guide to user interface design: An introduction to gui design principles and techniques, 3rd edition.
[2] Sikha Bagui. Database design using entity-relationship diagrams, second edition, Sep 2011.
[3] Micheal J Hernandez. Database design for mere mortals, Dec 1996.
[4] Miles A. Kimball. Visual design principles: An empirical study of design lore - miles a. kimball, 2013.
[5] Steven Roman. Access database design amp; programming, 3rd edition.
[6] Toby J. Teorey, Sam S. Lightstone, Tom Nadeau, and H.V. Jagadish. Database modeling and design, 4th edition.