Phase 3 Submission

State Alchemist Research and Mission Management System

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Introduction

This document presents the iterative conversion of the ER diagram designed in Phase 2 into:

- A mapped relational model
- A relational model in First Normal Form (1NF)
- A relational model in Second Normal Form (2NF)
- A relational model in Third Normal Form (3NF)

Each stage includes a concise explanation of changes made, followed by a snapshot of the corresponding relational model diagram.

1 Relational Model After Mapping ER to Relational Schema

Explanation

The ER model was translated to a relational schema following the standard mapping rules:

- Each strong entity type was mapped to a relation with its primary key.
- Weak/associative entities (e.g., relationships involving multiple keys) were mapped to relations containing the primary keys of participating entities as foreign keys.
- Multi-valued or composite attributes were replaced with simple atomic attributes in appropriate relations.
- Identifying and non-identifying relationships were mapped into foreign key constraints.

No normalization has been applied at this stage; the mapping is a direct translation from ER to relational form.

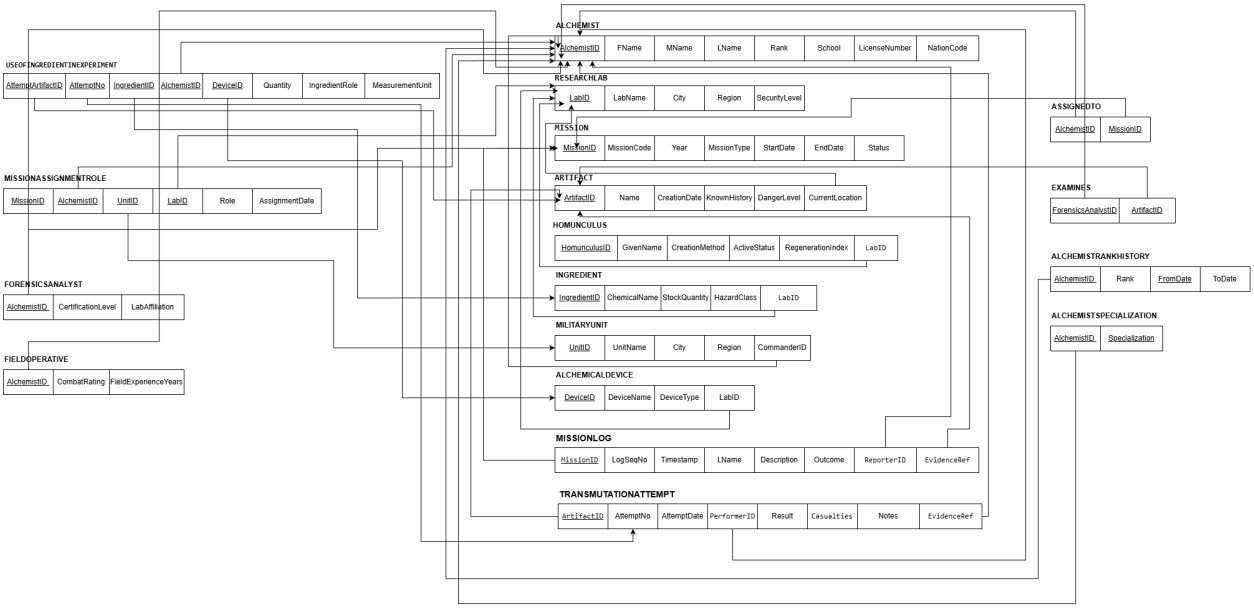

Figure 1: Relational Model (Direct ER Mapping)

2 Relational Model in First Normal Form (1NF)

Explanation

The relational model already satisfied 1NF because:

- All attributes are atomic.
- No repeating groups or nested relations were present.

Thus, no structural changes were required to convert to 1NF.

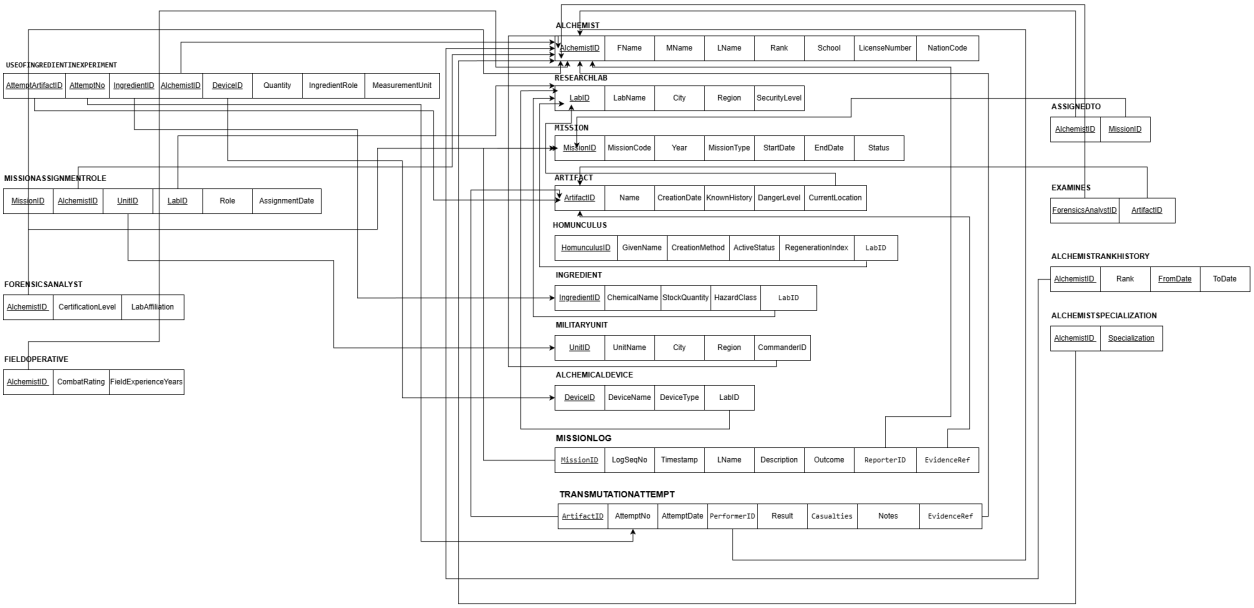

Figure 2: Relational Model in 1NF

3 Relational Model in Second Normal Form (2NF)

Explanation

To satisfy 2NF, partial functional dependencies on composite keys were removed. Changes include:

- In tables containing composite primary keys, non-key attributes depending only on part of the key were moved into separate relations.
- This included splitting many-to-many associative tables and ensuring that descriptive attributes depend on the full primary key.

After these adjustments, every non-key attribute depends on the entire primary key, satisfying 2NF.

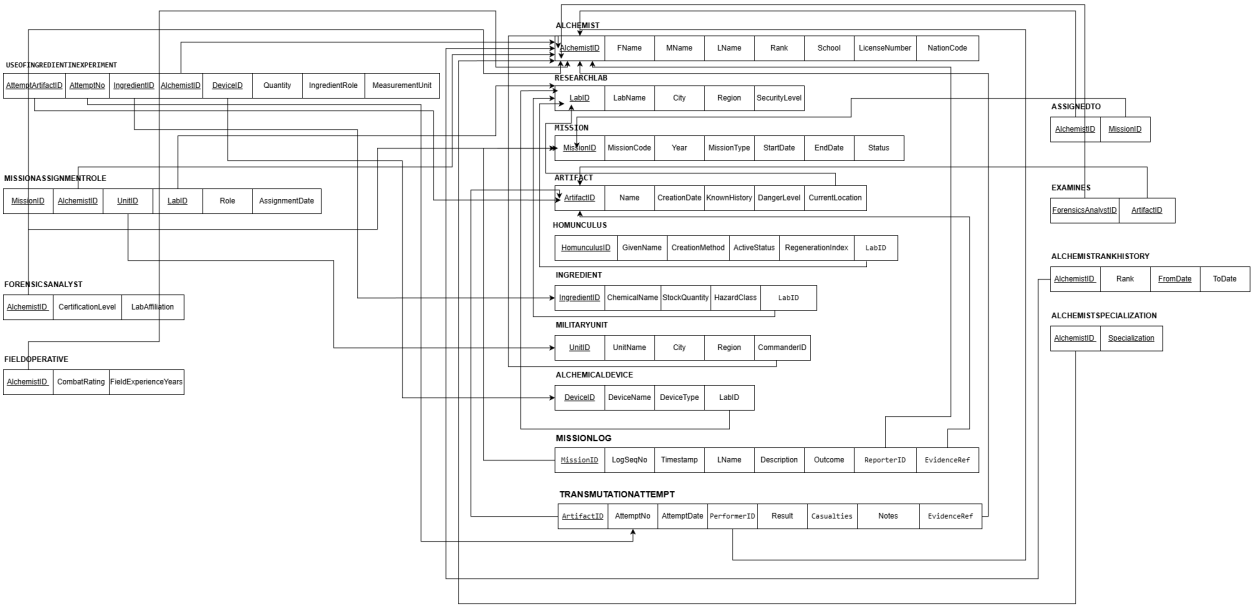

Figure 3: Relational Model in 2NF

4 Relational Model in Third Normal Form (3NF)

Explanation

To satisfy 3NF, transitive dependencies were removed. Major changes include:

- Separating `IngredientStock` from `Ingredient` to avoid Lab-dependent attributes being stored on the ingredient entity.
- Removing `Rank` from the `Alchemist` relation and storing rank history exclusively in `AlchemistRankHistory`.
- Replacing the textual attribute `LabAffiliation` in `ForensicsAnalyst` with a proper foreign key attribute `LabID`.
- Splitting the multi-attribute assignment relationship into:
  - `MissionAssignment` (Role, AssignmentDate)
  - `MissionAssignmentUnit`
  - `MissionAssignmentLab`
- Creating a separate `City` relation to remove the transitive dependency `City` → `Region`.

After these refinements, all relations contain only attributes that depend directly on their primary key and not on other non-key attributes, fulfilling 3NF.

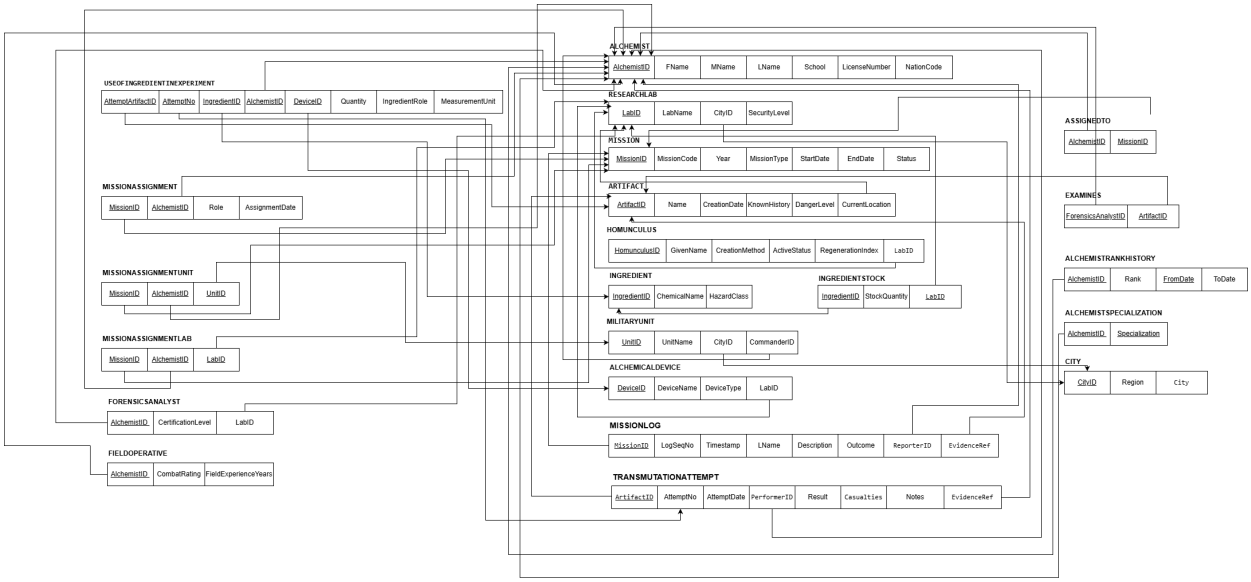

Figure 4: Relational Model in 3NF