Facade Pattern

Facade Pattern

1. Brief Introduction to Facade Pattern

1.1 What is Facade Pattern

The **Facade Pattern** is a structural design pattern that provides a simplified interface to a library, a framework, or any other complex set of classes. It defines a higher-level interface that makes the subsystem easier to use by wrapping a complicated subsystem with a simpler interface.

Key Components:

- **Facade**: The unified interface that clients interact with (CombatFacade in our case)
- **Subsystems**: The complex internal components hidden behind the Facade (CombatSystem, CombatUIController, CombatEventBus)

- **Client**: The code that uses the Facade instead of interacting with subsystems directly (CombatScene)

2. Previous Implementation and Problems

2.1 Original Implementation Approach

Before refactoring, `CombatScene` had to interact directly with multiple subsystems (`CombatSystem`, `Player`, `Monster`, `HandPileLayer`) to perform any combat operation.

Example: Ending a Turn (Original Implementation)

```
// CombatScene.cpp - 20+ lines of coordination logic
endTurnButton->addTouchEventListener([&](Ref* sender, Widget::TouchEventType type) {
    if (type == Widget::TouchEventType::ENDED) {
        if (isMyTurn) {
            isMyTurn = 0;
            CombatSystem::getInstance()->endTurnCardPlayed();  // Step 1
            CombatSystem::getInstance()->endTurn(Player::getInstance());  // Step 2

            // Step 3-6: Manually iterate all monsters
            for (int i = 0; i < CombatSystem::getInstance()->Monsters_.size(); i++) {
                auto monster = static_pointer_cast<Monster>(
                    CombatSystem::getInstance()->Monsters_[i]);
                if (monster->getHealth() > 0) {
                    CombatSystem::getInstance()->startTurn(monster);
                    monster->takeEffect();
                    CombatSystem::getInstance()->endTurn(monster);
                }
            }
        }
        CombatSystem::getInstance()->startTurn(Player::getInstance());  // Step 7
        isMyTurn = 1;
    }
});
```

2.2 Problems with Original Approach

1. Tight Coupling

- Client knows internal structure (monster list, turn sequence)
- Must call 7 different methods in correct order
- Any change to turn logic requires modifying client code

2. Code Duplication

- Same coordination logic repeated if other scenes need turn management
- Error-prone: easy to forget a step (e.g., skip dead monsters)

3. Mixed Responsibilities

- CombatSystem contains both game logic AND direct UI calls
- Cannot test game logic without instantiating Cocos2d-x UI framework

4. Direct UI Dependencies in CombatSystem

```
// Before: CombatSystem directly calls UI layer
auto scene = (CombatScene*)(Director::getInstance()->getRunningScene());
scene->creatureLayer->updateDisplay();  // Cocos2d dependency!
HandPileLayer::getInstance()->removeCard(card);  // Singleton UI access
```

---

3. Overall Refactoring Design

3.1 Architecture Overview

The refactored system introduces **CombatFacade** as the single entry point for all combat-related operations. We also extracted UI logic into **CombatUIController** and event handling into **CombatEventBus**.

Core Components:

```
Client (CombatScene)
    │
    └── CombatFacade (Single Entry Point)
            │
            ├── CombatSystem (Pure Game Logic)
            │       ├── Damage calculation
            │       ├── Turn management
            │       └── Card/Buff effects
            │
            ├── CombatUIController (UI Abstraction)
            │       ├── Player/Monster display
            │       └── Animations
            │
            └── CombatEventBus (Event System)
                    └── Publish-Subscribe events
```

3.2 Design Decisions

1. Facade as Orchestrator

- CombatFacade coordinates between subsystems
- Clients only interact with Facade
- All UI updates are automatic

2. UI Controller Extraction

- All Cocos2d-x specific code moved to CombatUIController
- CombatSystem uses `notifyUI*()` methods to delegate UI updates:
  - `notifyUICreaturesUpdated()` - Update creature displays
  - `notifyUIRemoveCard()` - Remove card from hand
  - `notifyUIDiscardPileUpdated()` - Update discard pile
- **20+ direct UI calls replaced** with UIController delegation

3. Event Bus for Decoupling

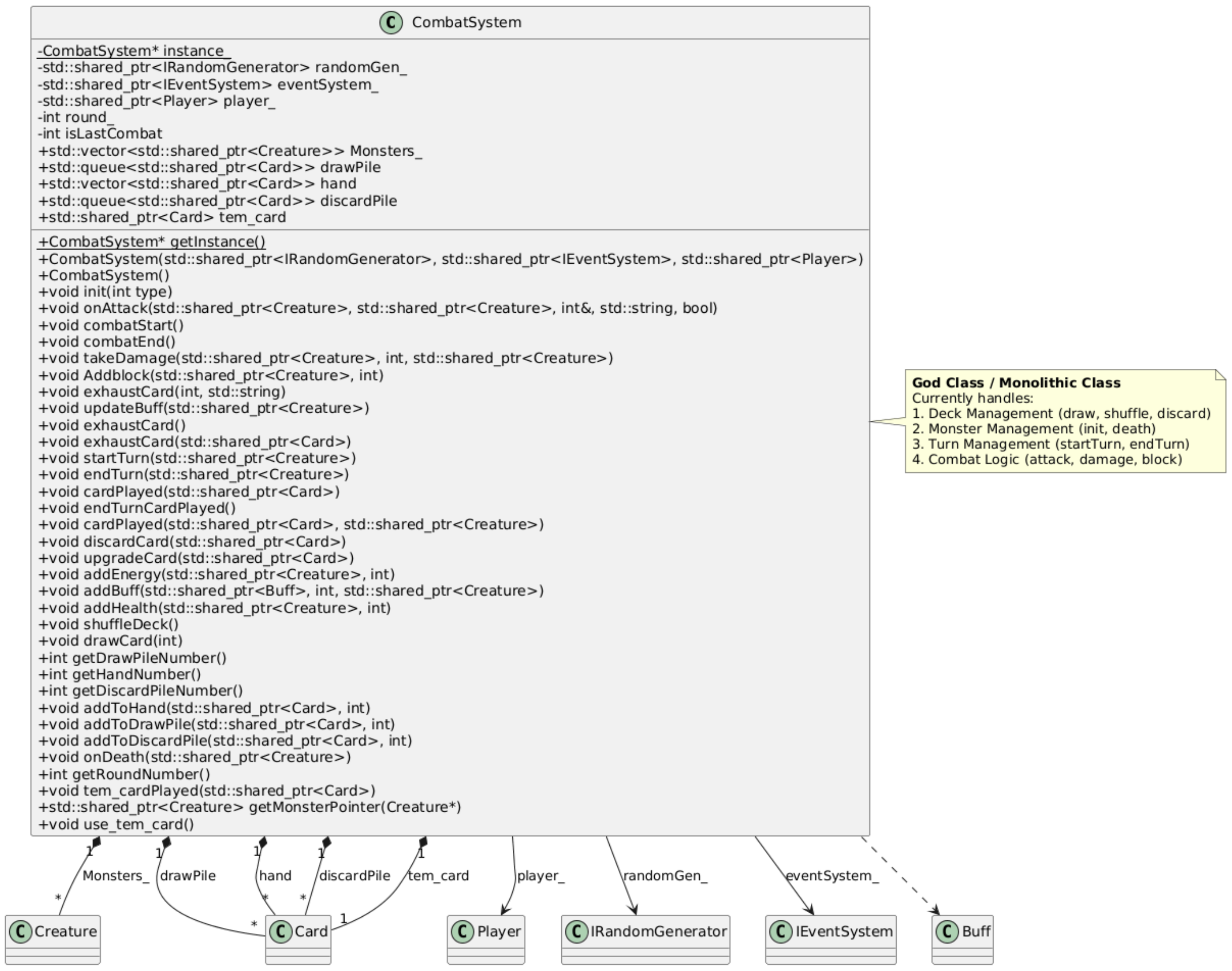
- Components communicate via events (Observer pattern)
- Easy to add new listeners (achievements, analytics, etc.)

4. Backward Compatibility

- Singletons kept for legacy code
- Gradual migration path

3.3 UML Class Diagram

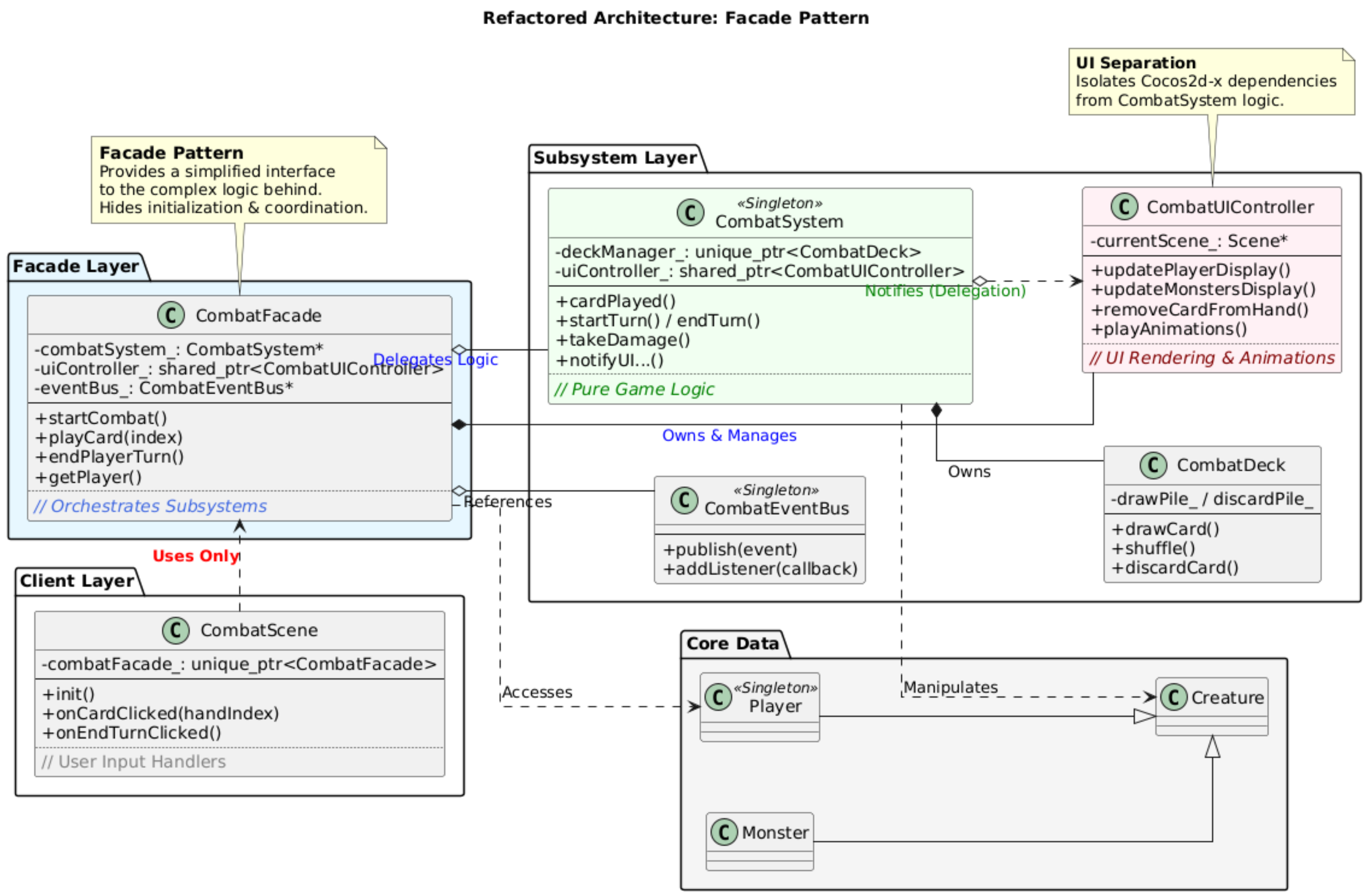
Before Refactoring (Direct Coupling)


CombatSystem
-CombatSystem* instance_
-std::shared_ptr<IRandomGenerator> randomGen_
-std::shared_ptr<IEventSystem> eventSystem_
-std::shared_ptr<Player> player_
-int round_
-int isLastCombat
+std::vector<std::shared_ptr<Creature>> Monsters_
+std::queue<std::shared_ptr<Card>> drawPile
+std::vector<std::shared_ptr<Card>> hand
+std::queue<std::shared_ptr<Card>> discardPile
+std::shared_ptr<Card> tem_card
+CombatSystem* getInstance()
+CombatSystem(std::shared_ptr<IRandomGenerator>, std::shared_ptr<IEventSystem>, std::shared_ptr<Player>)
+CombatSystem()
+void init(int type)
+void onAttack(std::shared_ptr<Creature>, std::shared_ptr<Creature>, int&, std::string, bool)
+void combatStart()
+void combatEnd()
+void takeDamage(std::shared_ptr<Creature>, int, std::shared_ptr<Creature>)
+void Addblock(std::shared_ptr<Creature>, int)
+void exhaustCard(int, std::string)
+void updateBuff(std::shared_ptr<Creature>)
+void exhaustCard()
+void exhaustCard(std::shared_ptr<Card>)
+void startTurn(std::shared_ptr<Creature>)
+void endTurn(std::shared_ptr<Creature>)
+void cardPlayed(std::shared_ptr<Card>)
+void endTurnCardPlayed()
+void cardPlayed(std::shared_ptr<Card>, std::shared_ptr<Creature>)
+void discardCard(std::shared_ptr<Card>)
+void upgradeCard(std::shared_ptr<Card>)
+void addEnergy(std::shared_ptr<Creature>, int)
+void addBuff(std::shared_ptr<Buff>, int, std::shared_ptr<Creature>)
+void addHealth(std::shared_ptr<Creature>, int)
+void shuffleDeck()
+void drawCard(int)
+int getDrawPileNumber()
+int getHandNumber()
+int getDiscardPileNumber()
+void addToHand(std::shared_ptr<Card>, int)
+void addToDrawPile(std::shared_ptr<Card>, int)
+void addToDiscardPile(std::shared_ptr<Card>, int)
+void onDeath(std::shared_ptr<Creature>)
+int getRoundNumber()
+void tem_cardPlayed(std::shared_ptr<Card>)
+std::shared_ptr<Creature> getMonsterPointer(Creature*)
+void use_tem_card()
God Class / Monolithic Class
Currently handles:
1. Deck Management (draw, shuffle, discard)
2. Monster Management (init, death)
3. Turn Management (startTurn, endTurn)
4. Combat Logic (attack, damage, block)
1
Monsters_
*
1
drawPile
*
1
hand
*
1
discardPile
*
1
tem_card
1
player_
randomGen_
eventSystem_
Creature
Card
Player
IRandomGenerator
IEventSystem
Buff

Key Issues:

- CombatScene directly depends on 4+ subsystems
- CombatSystem contains both logic AND UI calls
- Cannot test logic without UI framework

After Refactoring (Facade Pattern)



Key Improvements:

- Client only depends on CombatFacade
- CombatSystem delegates all UI through `notifyUI*()` methods
- Clear separation: Logic / UI / Events

4. Implementation Details

4.1 Core File Changes

```
Tongji_University_Slay_the_Spire/Classes/
├── CombatFacade.h/cpp         (NEW - Facade interface)
├── CombatUIController.h/cpp   (NEW - UI abstraction)
├── CombatEventBus.h/cpp       (NEW - Event system)
└── CombatSystem.h/cpp         (MODIFIED - UI delegation)
```

4.2 CombatFacade Interface

```
class CombatFacade {
public:
    static std::unique_ptr<CombatFacade> create();

    // Combat Flow
    void startCombat(int combatType = -1);
    void endCombat();
    void startPlayerTurn();
    void endPlayerTurn();

    // Card Operations
    bool playCard(int handIndex);
    bool playCardWithTarget(int handIndex, int targetIndex);
    int drawCard(int count = 1);
    void discardCard(int handIndex);

    // Combat Actions
    int playerAttack(int targetIndex, int damage);
    void playerDefend(int blockAmount);
    void playerAddBuff(const std::string& buffName, int stacks = 1);

    // Query Interface
    std::shared_ptr<Player> getPlayer() const;
    std::vector<std::shared_ptr<Monster>> getMonsters() const;
    std::vector<std::shared_ptr<Card>> getPlayerHand() const;
    bool canPlayCard(int handIndex) const;

private:
    CombatSystem* combatSystem_;
    std::shared_ptr<CombatUIController> uiController_;
    CombatEventBus* eventBus_;
};
```

4.3 Key Method: playCard()

```
bool CombatFacade::playCard(int handIndex) {
    // 1. Validate state
    if (!isCombatActive_ || !isPlayerTurn_) return false;

    // 2. Validate card
    auto hand = getPlayerHand();
    if (handIndex < 0 || handIndex >= hand.size()) return false;

    auto card = hand[handIndex];
    if (card->getEnergyCost() > getPlayer()->getCurrentEnergy()) return false;

    // 3. Execute logic
    combatSystem_->cardPlayed(card);
    // 4. Update UI (automatic)
    if (uiController_) {
        uiController_->removeCardFromHand(card);
        uiController_->updatePlayerDisplay(getPlayer());
    }

    // 5. Publish event
    eventBus_->publishCardPlayed(card->getName(), handIndex);
    return true;
}
```

4.4 CombatUIController

Isolates all Cocos2d-x specific code:

```
class CombatUIController {
public:
    static std::unique_ptr<CombatUIController> create();
    bool init(cocos2d::Scene* scene);

    // Display Updates
    void updatePlayerDisplay(std::shared_ptr<Player> player);
    void updateMonstersDisplay(const std::vector<std::shared_ptr<Monster>>& monsters);
    void updateAllCreaturesDisplay();
    void updateEnergyDisplay(int current, int max);
    void updateDiscardPileDisplay(int count);

    // Card Operations
    void addCardToHand(std::shared_ptr<Card> card);
    void removeCardFromHand(std::shared_ptr<Card> card);
    void removeCardSprite(std::shared_ptr<Card> card);

private:
    cocos2d::Scene* currentScene_ = nullptr;
    HandPileLayer* handLayer_ = nullptr;
    CreatureLayer* creatureLayer_ = nullptr;

    void safeUpdateUI(std::function<void()> updateFunc);
};
```

4.5 CombatEventBus

Implements Publish-Subscribe pattern for loose coupling:

```
class CombatEventBus {
public:
    static CombatEventBus* getInstance();
    // Listener Management
    int addListener(int eventType, EventListener listener, int priority = 0);
    bool removeListener(int listenerId);

    // Event Publishing
    void publish(int eventType, std::shared_ptr<void> data = nullptr);
    void publishCardPlayed(const std::string& cardName, int handIndex);
    void publishTurnEvent(bool isPlayerTurn, int roundNumber);
};

// Event Types
namespace CombatEventType {
    const int CARD_PLAYED = 1001;
    const int ATTACK = 1002;
    const int DAMAGE_TAKEN = 1003;
    const int TURN_START = 1005;
    const int COMBAT_END = 1008;
}
```

---

5. Advantages

5.1 Simplified Client Code

Before (20+ lines):

```
void CombatScene::onCardPlayed(Card* card) {
    if (Player::getInstance()->getCurrentEnergy() < card->getCost()) return;
    Player::getInstance()->energyChange(-card->getCost());
    CombatSystem::getInstance()->cardPlayed(card);
    this->creatureLayer->updateDisplay();
    HandPileLayer::getInstance()->removeCard(card);
    HandPileLayer::getInstance()->updateEnergyDisplay();
    // ... more UI updates
}
```

After (1 line):

```
void CombatScene::onCardPlayed(int handIndex) {
    combatFacade_->playCard(handIndex);  // All handled!
}
```

5.2 Complete UI/Logic Separation

Metric	Before	After
Direct UI calls in CombatSystem	20+	0
`notifyUI*()` delegation methods	0	10+
Unit testability	❌	✅

5.3 UI Delegation Pattern

```
// CombatSystem - Pure logic, no Cocos2d dependencies
void CombatSystem::endTurn(std::shared_ptr<Creature> creature) {
    // Game logic...
    for (auto& card : hand) {
        discardPile.push(card);
        notifyUIRemoveCardSprite(card);  // Delegation, not direct call
    }
    notifyUICreaturesUpdated();  // Replaces scene->creatureLayer->updateDisplay()
}

void CombatSystem::notifyUICreaturesUpdated() {
    if (uiController_) {
        uiController_->updateAllCreaturesDisplay();
    }
}
```

5.4 Testability

```
class MockUIController : public CombatUIController {
public:
    void updatePlayerDisplay(std::shared_ptr<Player>) override { updateCount++; }
    int updateCount = 0;
};

TEST(CombatTest, PlayCardUpdatesUI) {
    auto mockUI = std::make_shared<MockUIController>();
    auto facade = createTestFacade(mockUI);
    facade->playCard(0);
    EXPECT_EQ(mockUI->updateCount, 1);  // Verifiable!
}
```

5.5 Event-Driven Extensions

```
// Add features without modifying Facade!
facade->addEventListener(CombatEventType::CARD_PLAYED,
    [](auto& e) { AudioEngine::play2d("card.mp3"); });
```

---

6. Trade-offs

6.1 Advantages Summary

Benefit	Description
Simplified API	30+ lines → 1 line per operation
UI Separation	20+ direct calls → 0 (all delegated)
Testability	Can mock UIController for unit tests
Extensibility	Add features via events, no code changes

6.2 Limitations

1. CombatSystem Remains a God Object (~950 lines)

- Facade **wraps** complexity, doesn't **eliminate** it
- Further decomposition (DamageCalculator, TurnManager, etc.) deferred

2. Additional Abstraction Layer

- ~1000 lines of new code (Facade + UIController + EventBus)
- Learning curve for new developers

3. Backward Compatibility Constraints

- Singletons remain directly accessible
- `getSelectedCards()` has fallback for null `uiController_`

---

7. Conclusion

Summary

Component	Purpose	Lines
CombatFacade	Unified interface, orchestration	~400
CombatUIController	UI abstraction	~400
CombatEventBus	Publish-subscribe events	~200

Results

Metric	Before	After
Client code complexity	20+ lines	1 line
Direct UI calls in CombatSystem	20+	0
Unit testability	❌	✅

Key Insight

```
Facade = "Make the client's life easier without rewriting the world"
UI Separation = "Make the logic testable without UI dependencies"
```

Two-Layer Improvement:

1. **External**: CombatScene ↔ CombatFacade ↔ Subsystems
2. **Internal**: CombatSystem → notifyUI*() → CombatUIController

Future Work:

- Decompose CombatSystem into smaller classes (DamageCalculator, TurnManager, etc.)
- Remove singleton dependencies
- Add comprehensive unit test suite