Object Oriented Analysis and Design

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Description

This course provides the skills and process to capture requirements the Analysis and Design phases of a project's life cycle. RUP will be presented as the basic Life Cycle. Several techniques will be taught to assist in the creation of the necessary UML diagrams used to document requirements. Special emphasis will be placed on Use Case development.

Students will do several in class exercises to practice the techniques and diagrams.

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Objectives *Students will be able to:*

- Describe difference between Structured Analysis and Design and OOAD
- Describe sets of documents that precede the A/D activities
- Build a simple Work Flow Process model
- Build detailed Use Cases to show how activities will be performed
- Use CRC (Class / Responsibility / Collaboration) cards to identify Classes , methods and interaction of Classes
- Build a Class Diagram which includes Design level detail
- Discuss the translation of Use Cases to Test Cases

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Course Outline

- Object Oriented Overview
- Object Oriented Strengths
- Deliverables from Analysis
- How to begin Analysis
- Techniques to Elicit Requirements during Analysis
- Role of UML
- Deliverables from Design
- Translating requirements to Specifications for developers
- Miscellaneous :
  - Translating Use Cases to Test Cases

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Background

- Traditional
  - Waterfall
  - Program and data separation
  - Program linkage issues
  - System Department Initiated Projects

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Object Oriented features

- Models real world entities (Classes) which have behaviors and state (data)
- Pillars
  - Encapsulation
    - Protection of data
  - Inheritance
    - Sharing but not source code
  - Polymorphism
    - Build and process that which can not be shared
    - Execute “specific” processes when Inherited code is not sufficient

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Encapsulation

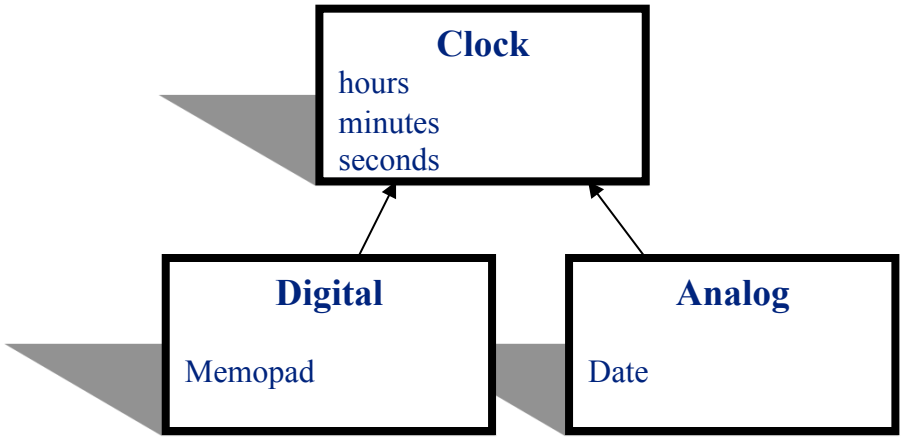
- A Class must shield its data and hide the internal working of its methods (behaviors)

- Examples:
  - Clock
  - Car

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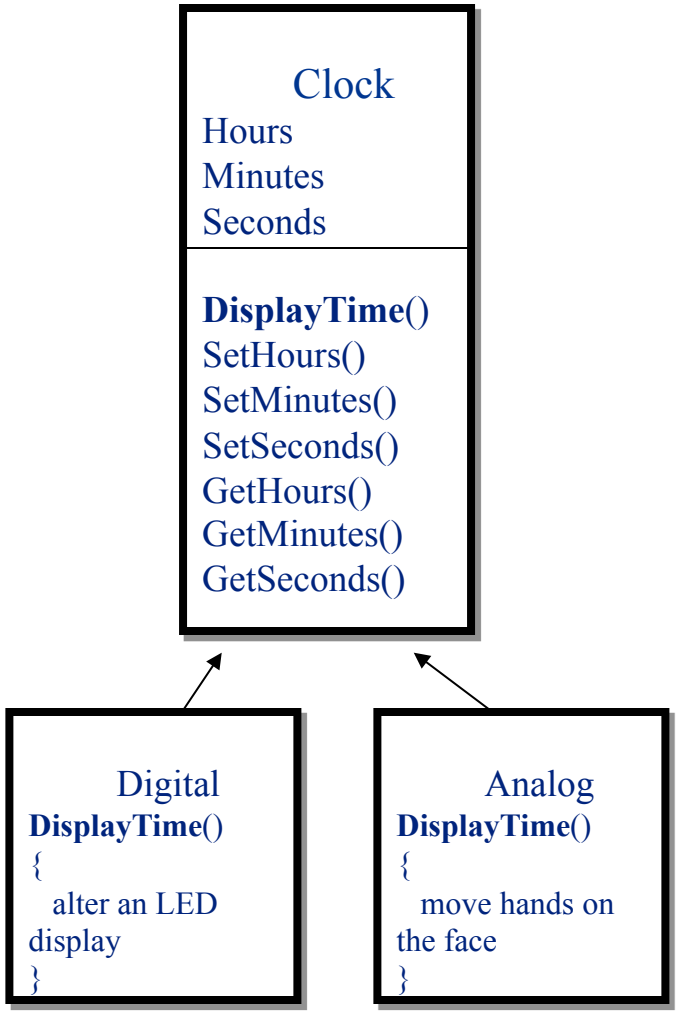
Inheritance

- Sharing of code and reuse of code
- How is this accomplished ?

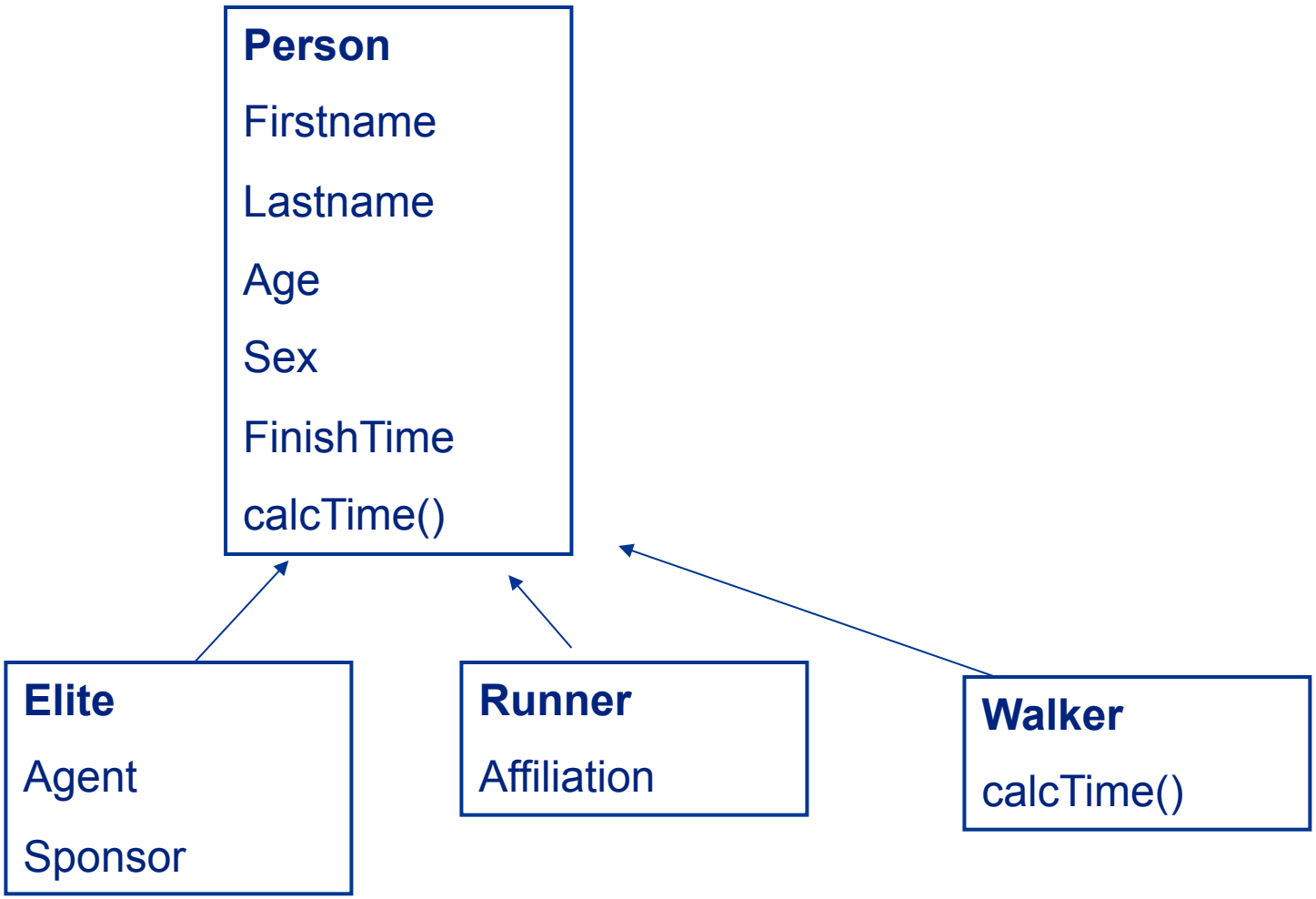


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Polymorphism

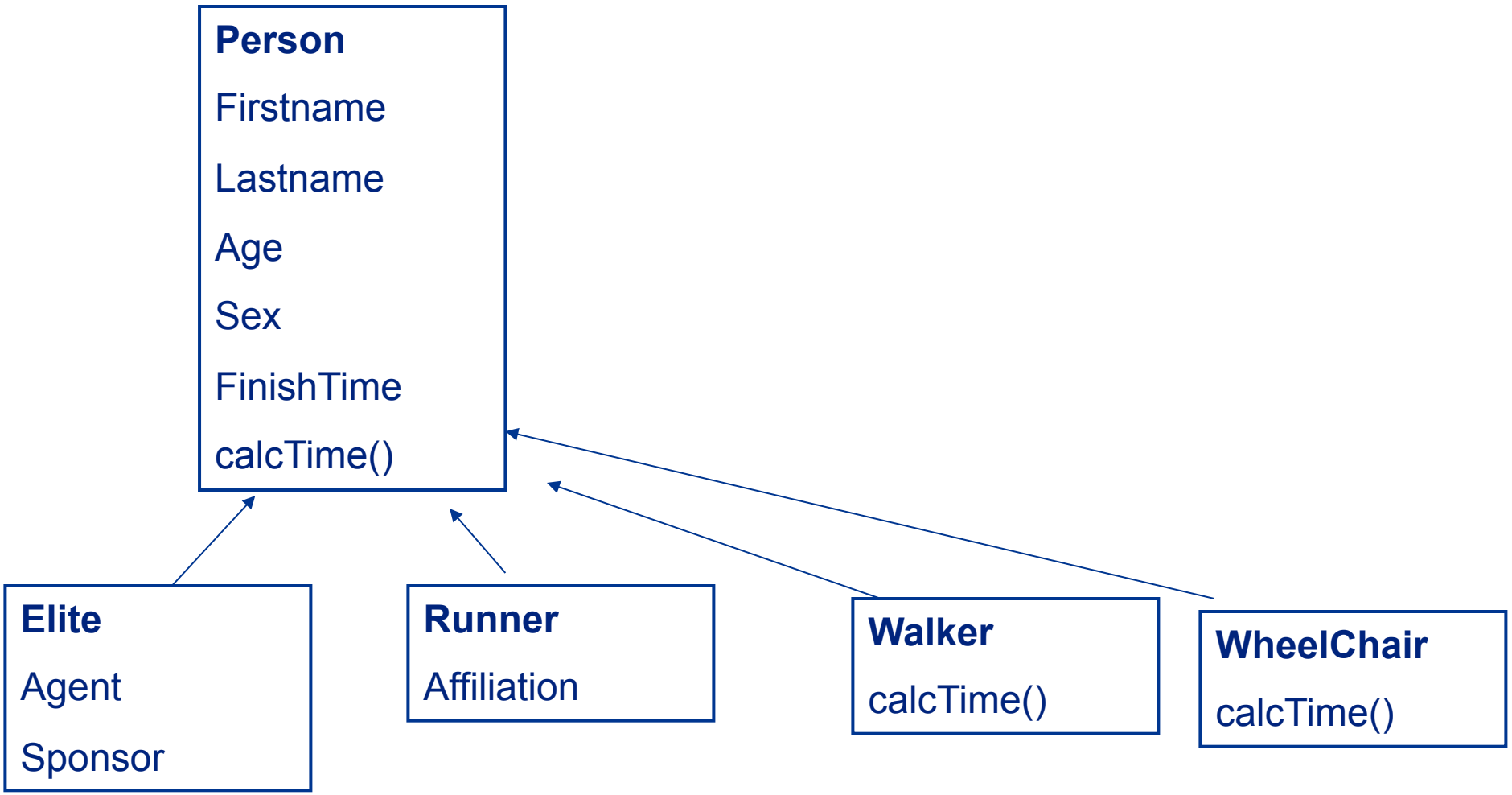


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```
for (int iCtr = 0 ; iCtr < 15000; iCtr++)
    arrPart[iCtr].calcTime();
```


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```
for (int iCtr = 0 ; iCtr < 15000; iCtr++)
    arrPart[iCtr].calcTime();
```


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Process / Project Plan

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System Development Life Cycle (SDLC)

- What gets done first, next and last
- Defines the steps to take a business idea and transform it into a working system
- Project Plan / Process
- Examples
  - Yordin - Structured Analysis and Design
  - RUP
  - Corporation proprietary Development Life Cycles

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Life Cycle - *Generic*

Any and everything built goes through this generic life cycle :

- **Analysis**
  - Builds a set of **requirements** based on what has been identified in the Project Charter
- **Design**
  - Builds a set of **specifications** to guide the implementation efforts
- Implementation
- Testing
  - Artifacts from Design may help structure Testing

– Production

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Structured Analysis and Design

Defines a set of process and stages leading up Implementation (Coding)

Stage 0 – Feasibility study

Stage 1 – Investigation of the current environment

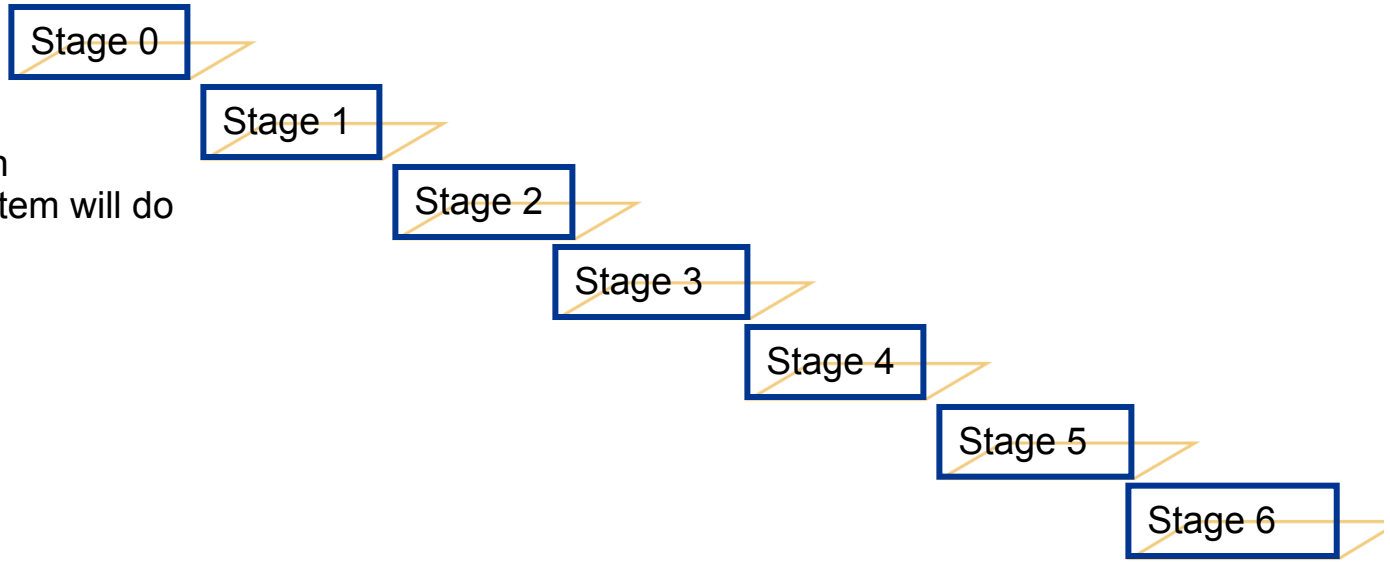
Stage 2 – Business system options

Stage 3 – Requirements specification
Describes WHAT the system will do

Stage 4 – Technical system options

Stage 5 – Logical design
Data catalog
Logical data structure

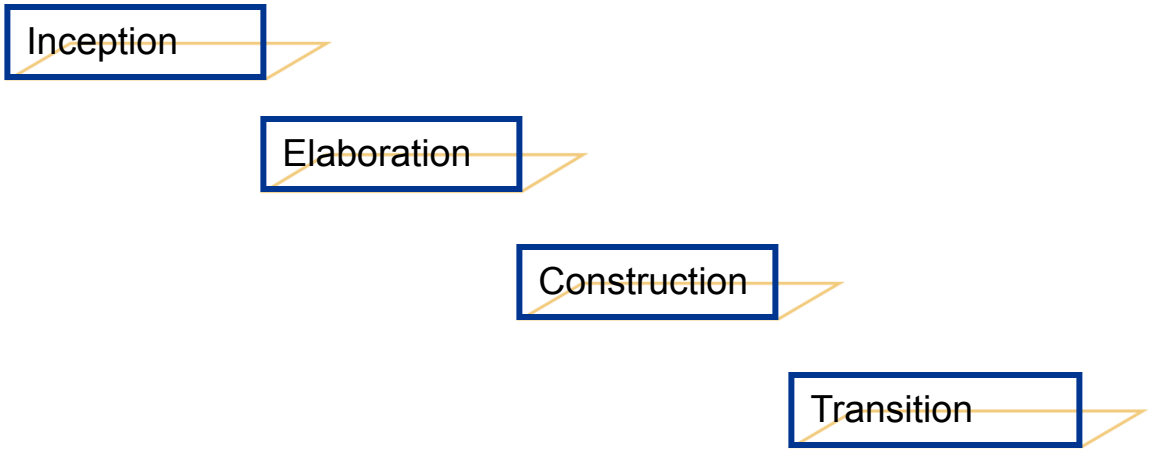
Stage 6 – Physical design
Coding specifications and Physical data base



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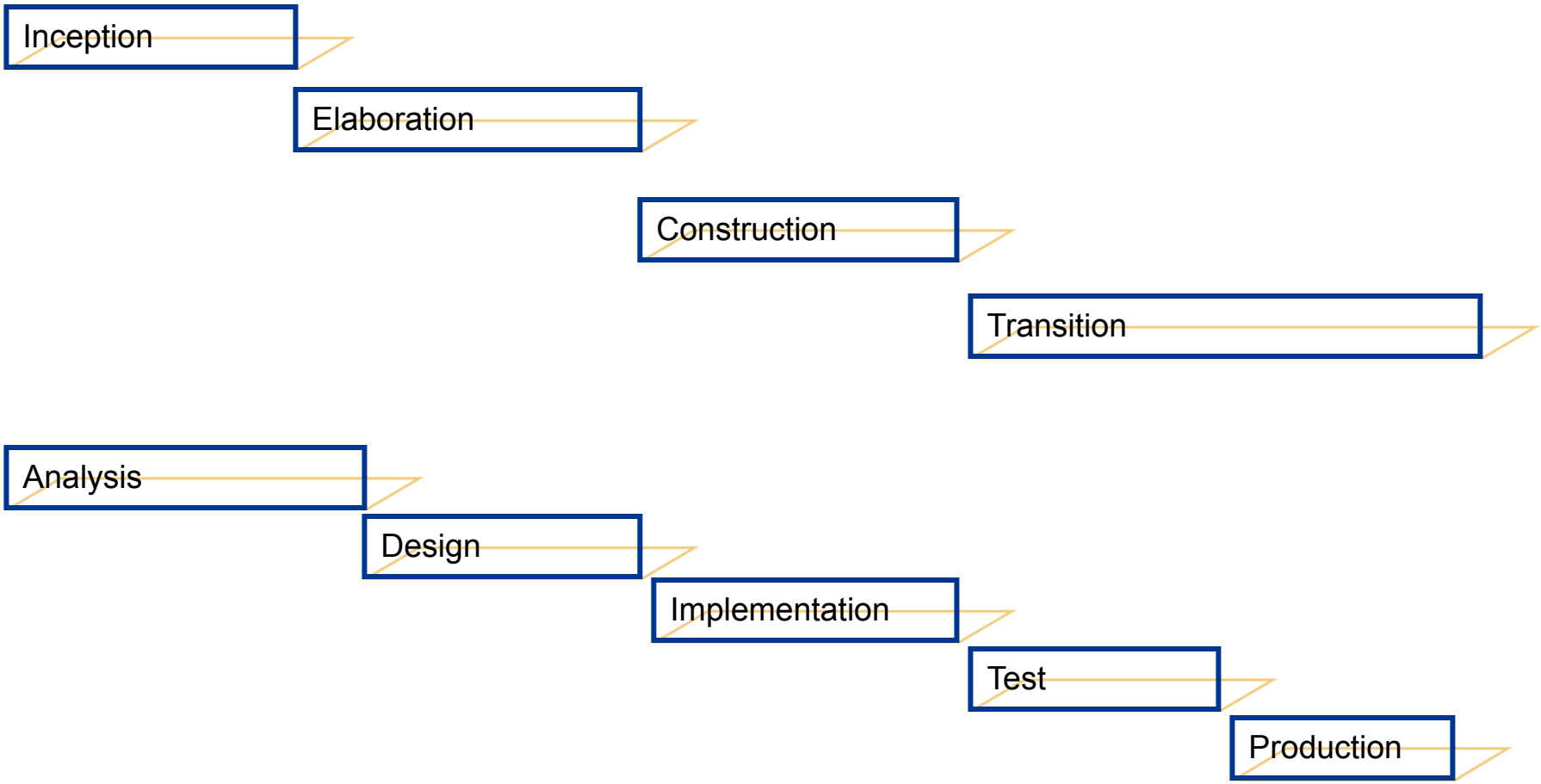
Unified Process (UP) formerly Rational Unified Process

- Inception
  - Business case / Project Charter / Scope
  - Proof of concept
- Elaboration
  - Scope Refinement / Requirements (Use Cases)
  - Architecture
- Construction
  - Define Iterations
  - Implement software based on selected Use Cases
- Transition
  - User Testing / Acceptance
  - Measure success



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UP overlay with Generic Life Cycle



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UP – Critical Success Factors

- Project Management
  - The Project plan must support the release / version / iterative process
- Scope Management
  - Ability to define an iteration (release) based on a well scoped set of features
- Change Management
  - The entire development team must subscribe to a formal change management process. This assures the system development activities are responsive to changes in the environment – User needs, legal issues, financial pressures, etc
- Risk Management
  - Activities / Events within the project are constantly being evaluated and rated as to their possibility of occurring and potential for undermining the project's success.

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Problem Definition

- Business Case
  - Corporate context and rationale for a development effort

- Project Charter
  - License to proceed with a project to implement development effort

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Business Case Example

Generally Written by a Business Architect who is intimately involved in the strategic direction and policies of the corporation. Has the following general structure / content:

- Introduction/Background
- Business Objective
- Current Situation and Problems / Opportunity Statement
- Critical Assumption and Constraints
- Analysis of Options and Recommendations
- Preliminary Project Requirements
- Budget Estimate and Financial Analysis
- Schedule Estimate
- Potential Risks

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Project Charter Example

Written by the project manager and defines the scope and high level requirements for a project as extracted from the Business Case. Considered the “license” to perform the project and contains the following content:

- Project Title
- Project Start Date
- Project End Date
- Budget Information
- Project Managers
- Project Objectives
- Project Approach
- Roles and Responsibility

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Exercise

Read Case Study

For the new system that is being requested, write several:

- Objectives
- Risks
- Assumptions
- Constraints

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Business Requirements Document - Example

Written by the Business Analyst and represents the first level of Requirements. It contains a refined description of scope and objectives . A large component of the BRD are the Use Case Scenarios which reflect user requirements at a fairly detailed level

▪Scope

- Streamlining the registration process and provide central flow of the money for auditing purposes. As part of streamlining an online system it is desirable to relieve some of the mail burden.
- The Walk-in registration process works fine since additional volunteers can be added to this process to handle the load. Auditing needs to be addressed for online and mail-in registration and t-shirts and for this phase must include a mechanism to check each person who handles money.
- The system should be part of a website that is easy for participants to use, contains all needed information regarding the race and is attractive to potential sponsors.

▪Business Objectives

- Obj – 1 Streamline registration process to reduce Registrars load by 50%
- Obj – 2 Centralize all money inputs and deposits
- Obj – 3 Provide an audit balance of registrations and tshirt orders

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Business Requirements Document (*continued*)

1.3 **Risks**

Risk – 1	Committee must allocated funds for development
Risk – 2	Users and SMEs may not be available due to volunteer status
Risk – 3	Scheduling – Live date is September 1

1.4 **Statement of Need/Request/Direction**

- Streamlining the registration process and provide central flow of the money for auditing purposes. As part of streamlining an online system it is desirable to relieve some of the mail burden.
- Auditing needs to be addressed for online and mail-in registration and t-shirts and for this phase must include a mechanism to check each person who handles money.
- The system should be part of a website that is easy for participants to use, contains all needed information regarding the race, is attractive to potential sponsors.

1.5 **List of Features**

Feature - 1	Online system to register runners and sell tshirts
Feature - 2	Online System to allow Tshirt Only sales
Feature – 3	Reporting system which reconciles money deposits
Feature – 4	Contains information about sponsorship levels
Feature – 5	Communication ability for pending problems
Feature – 6	Centralization of money flow
Feature – 7	Coordinate communications to participants

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Business Requirements Document (*continued*)

1.6 Assumptions/Contraints

Assump –	1	Funds available to develop
Assump –	2	Several volunteers must be able to work from home
Const –	1	Must be available Sept 1 – November 22

1.7 Scope/Priority of features

a. List of features by release

Feature – 6	Release 1
Feature – 7	Release 1
Feature – 3	Release 1
Feature – 1	Release 2
Feature – 2	Release 2
Feature – 5	Release 2
Feature – 4	Release 3

b. Context diagrams/WPM *(see Attached for Streamlining of process)*

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Analysis

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Goals of Analysis

- Determine requirements
  - Depends on what has been done
    - Project Charter
    - Business Requirements Document (BRD)
    - Elicitation
- Capture requirements
  - Corporate standards for Documentation
  - Unified Modeling Language (UML)
  - Textual documents

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Elicitation Techniques

- Current documentation
- Interviews
- Focus groups
- Brainstorming

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Capturing Requirements

- Context Diagram

- Unified Modeling Language (UML)
  - Process
    - Workflow Process Model (WPM)
    - Use Cases
  - Data
    - CRC
    - Class diagram versus Entity Relationship Diagram (ERD)

  - Glossary / Dictionary / Definition of Terms

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Unified Modeling Language (UML)

- Purpose
  - Specify, Visualize and document artifacts for Systems Development
- Developed by Booch, Jacobson and Rumbaugh
- Adopted by the Object Management Group (OMG) in 1997
- Accepted by the International Organization for Standardization (ISO)

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Categories of UML Diagrams

- Structure
  - **Class**
  - Package / Component
- Behavior
  - **Activity**
  - State
  - **Use Case**
- Interaction
  - **Sequence**
  - Collaboration

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Context Diagram

- Actors
- Interaction
- Advantages:
  - Gets a group talking and focused
  - Clarifies Scope

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Context Diagram

- Top level of abstraction independent of methodology
- Notations
  - Terminators/Actors (Interface with system)
  - Interactions to/from system (data ,control, material flows)
- Strength of diagram
  - Not a rigid structure
  - Good for group participation
  - Works in language of user
  - Sessions keep moving along
- Weakness
  - No consistency in labeling
  - Further explanation may be needed
  - May need to be translated to another diagram to fit methodology
  - May not be kept up to date

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Terminators/Actors

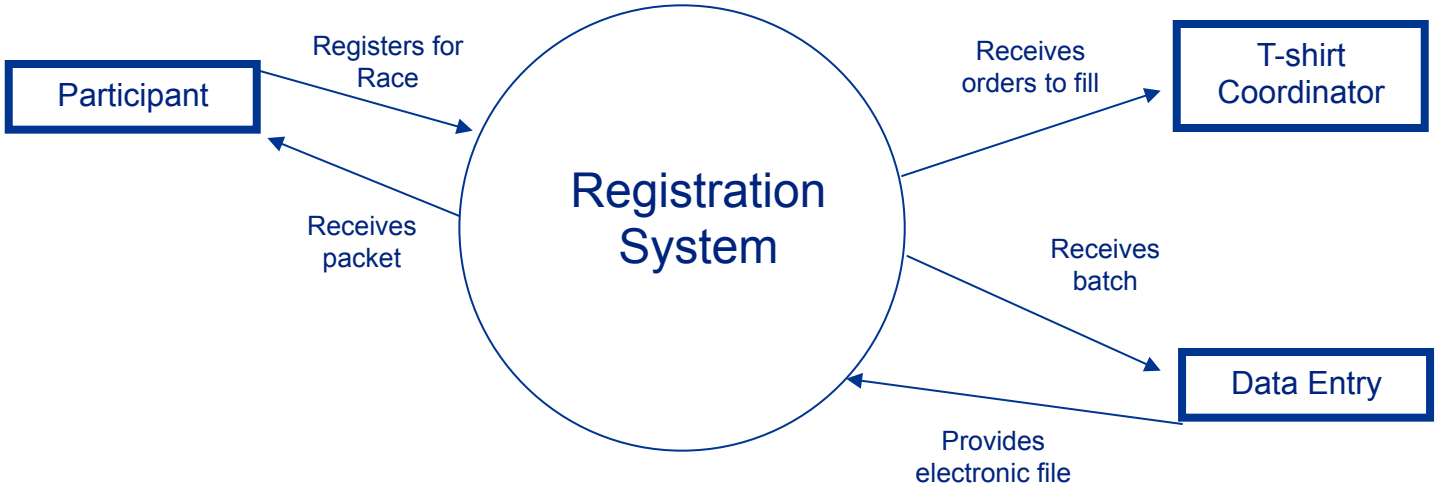
- Entities that interact with the System
- Designated as boxes
- Additional definitions/elaborations of actors kept in Actor Directory

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Interactions

- Flows to and from System to Actors
- Types of Flow
  - Data
  - Materials
  - Control

- *Exercise – Add to this Context Diagram*



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WPM

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Workflow Process Model (WPM)

- Part of UML which assists the modeling of process including the As-Is and To-Be
- Puts Processes (Use Cases) in sequence
- Show relationships of the primary Actors of processes

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Workflow Process Modeling - WPM

- Depicts roles, responsibilities and routes
- Roles (actors) are the performers of an action
- Responsibilities are tasks that the actors perform
- Routes are the workflows and decisions that connect the tasks

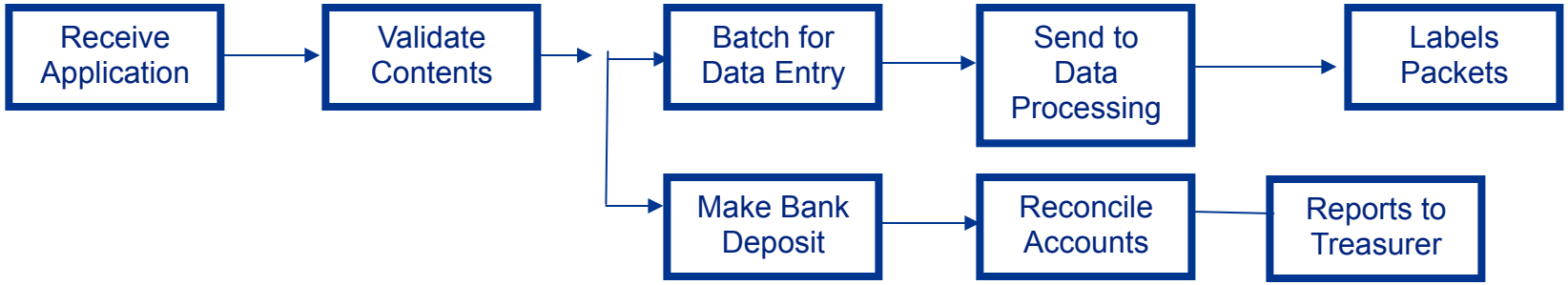
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Overall Process Map

- The overall process map shows the flow of processes in the system
- This forms the essence of the process by showing WHAT the system does not WHO is involved or HOW a step in the process is performed
- Strengths
  - Identifies sequence in an “As-Is” model which can point out opportunities to consolidate and streamline

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High level WPM Registration



Event Triggers – Registration received in PO Box (box checked by Registrar)

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High Level WPM - *Continued*



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What is a Process?

- Set of actions that have meaning to the business
  - Open Account
  - Pay Claim
  - Register for Class
  - Matriculate Student
  - Withdraw Cash
- A process delivers a result that has value to the customer of the process.
- It is not a function which is a set of skills such as customer service, engineering, audit or shipping to name a few
- It is not a singular task but rather a sequence of tasks

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Naming a Process

- Usually a present tense verb/noun combination which identifies the **intended** result.
- For example:
  - Receive Order
  - Assemble Order
  - Ship Order
  - Register for Class
- The noun is probably a business object/entity

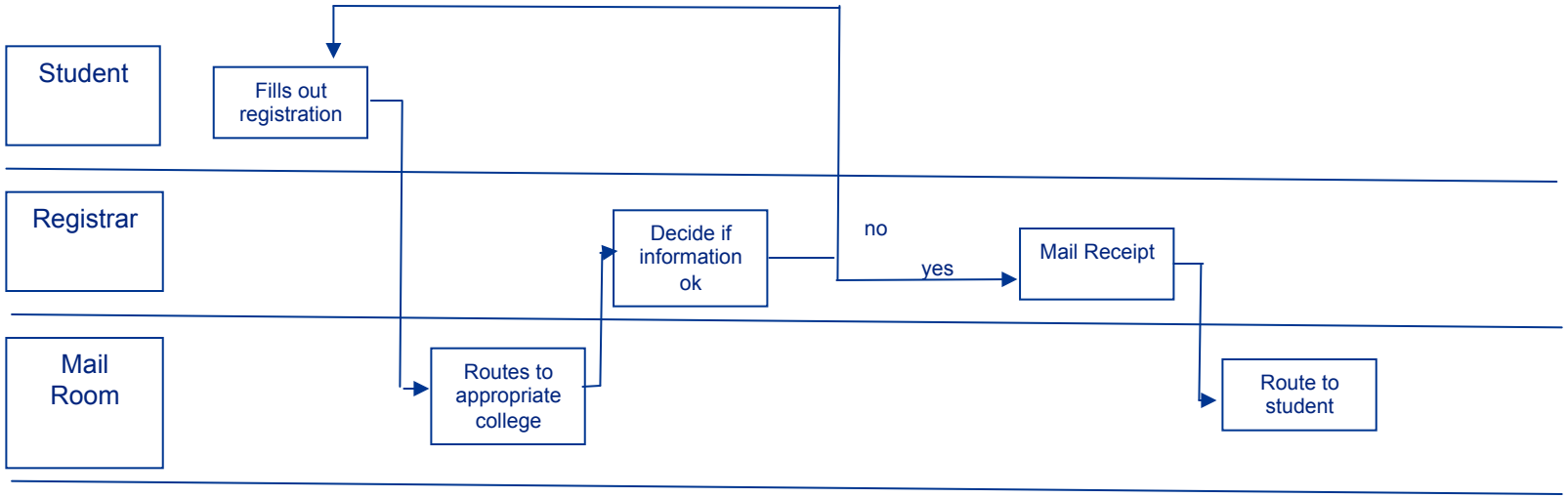
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Swimlane diagram

- Shows who does what and when
- Very easy to read
- Can contain multiple levels of detail which aid in building
- Focuses on handoff between actors and flow within an actor's responsibilities of a process
- NOT a step by step flow chart of activities within a process

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Swimlane Diagram Example



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Actors

- A person, persons, organization, job function, information system or automated device that handles the work between the event and the results of the process
- Add value but also add delays
- Generally moves work through the process

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Process Steps

- A set of tasks carried out by an actor
- May be abstracted to include several tasks. This helps keep the model at a high level
- Flow lines across indicate precedence
- Flow lines to another lane indicate a handoff

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WPM Desk *Exercise*

- Cable Company Customer Service
  - Customer Service – primarily responsible for assisting customers who are having difficulties with service. A customer first interacts with a voice response unit which routes the call to next available representative. The customer is identified and information about the problem is logged. A simple features question is dealt with and logged. A new service request is logged and routed to appropriate department. An equipment or software problem is transferred to the Repair Department and the request is put in a "pending resolution" bin. The Repair Department will complete a form when problem is resolved and return to Customer Service who will close out problem.
  - Repair Department – Calls may come in directly to them or referred by Customer Service. A technician generally can solve the problem using an automated diagnostic tool . If not a referral is made to an outside contractor for an onsite problem resolution. If originated from Customer Service then a form must be sent back to detail the action taken.

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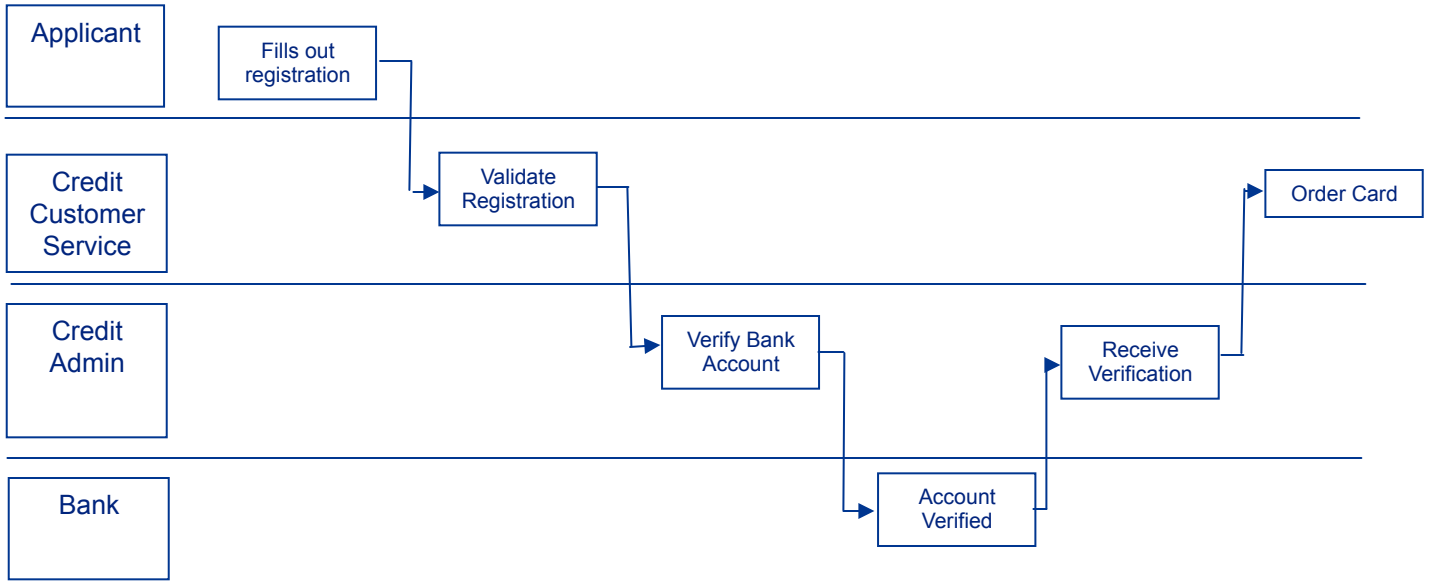
Levels of Detail

- The WPM can represent as many levels of details as desired. However, at the specific task level of an actor, the Use Case model will serve best
- At the first level of abstraction the WPM should focus on **handoffs** among actors.
- At the next level (2^{nd}) the model will show down additional steps within the **flow** of each actor and may indicate branching
- At the lowest level the model we want to show **HOW** the process is performed. The **Use Case** serves this purpose.

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Level 1

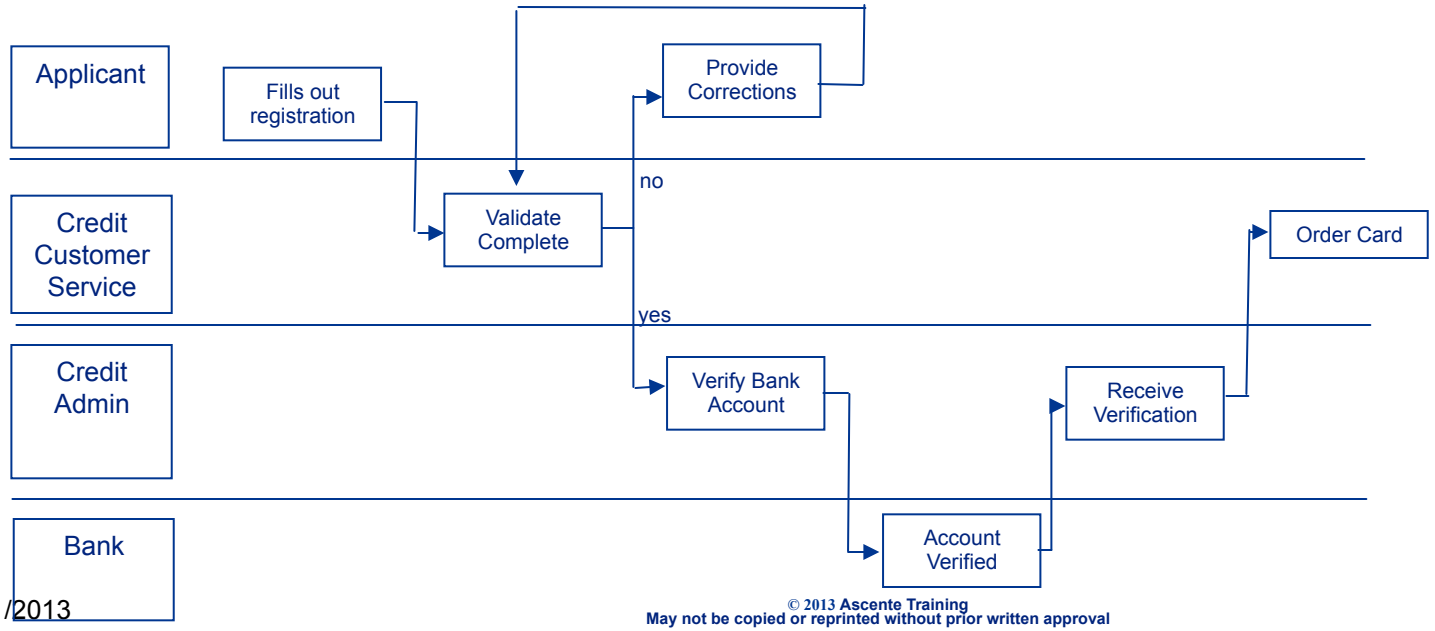
- Focus is on interaction among actors
- Consider each actor's steps to be a set of tasks that begin and end with a handoff



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Level 2

- Identifies the important steps that affect the flow and performance of the process
- Shows “significant” decisions
- Identifies specific steps before and after a handoff that may affect performance
- Shows iteration between steps
- Considerably larger than level 1



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Use Case

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What is a Use Case

- A consistent (part of Unified Modeling Language) textual format used to elicit, analyze and document requirements
- Describes **how** an actor will interact with the system to accomplish a particular task
- Can be the primary form of requirements documents for Business, User, Functional and User Interface Requirements
- Describes normal flow and alternate/ exception flow
- Can form bases for test case scenarios

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Use Case Model

The Use Case Model is comprised of :

- Use Case Diagram (*optional*)
- Use Case Scenarios
- Rules
- Glossary

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Determining the Use Cases

- Use the Context Diagram to validate the Actors
- The Interactions from the Context Diagram establish a good basis for the Use Cases
- If a Workflow Process Model (WPM) exists, then many of the processes will equate to Use Cases

Deliverable:

List of Use Cases

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Actor

- A person, persons, organization, job function, information system or automated device that handles the work between the event and the results of the process
- Add value but also add delays
- Generally moves work through the process

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What is a Use Case?

- Set of actions that have meaning to the business
  - Open Account
  - Pay Claim
  - Register for a Class
  - Matriculate a Student
  - Withdraw Cash
- A Use Case is a sequence of tasks by an actor that delivers a result that has value to the business.
- It is not a function which is a set of skills such as customer service, engineering, audit or shipping to name a few
- It is not a singular task but rather a sequence of tasks

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Naming a Use Case

- Usually a verb/noun combination which identifies the intended result.
- Has meaning to the customer
- For example:

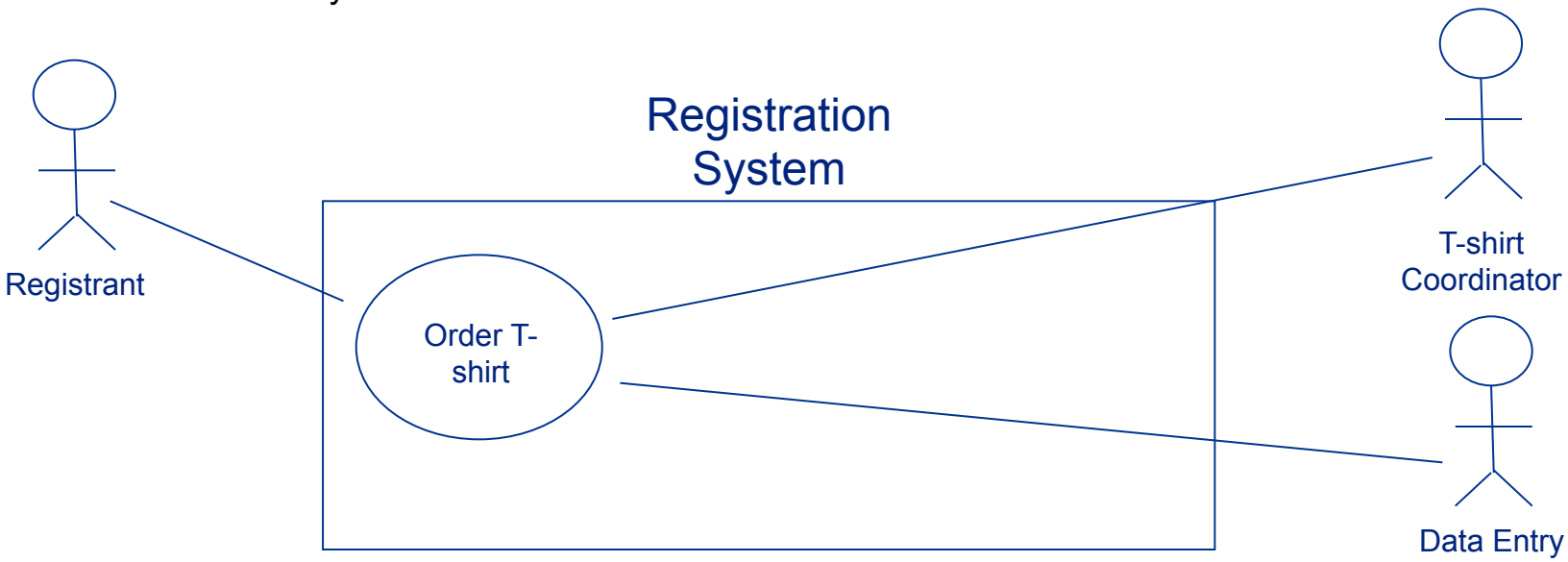
  Receive Order
  Assemble Order
  Ship Order
  Register for a Class

- The noun is probably a business object/entity
- Keep in the present tense
- Avoid weak words that do not say WHAT is happening such as :
  Manage
  Maintain

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Use Case Diagram

- Comprised of Actors, Use Cases and association lines within the context of the system
- Shows actors interacting with the processes(Use Cases)
- Strengths
  - Focus on Use Case which itself is a living artifact. Most useful for setting context to ONE Use Case.
  - Fleshes out actors
- Weaknesses
  - May spend more time enforcing USE Case Names which may limit creativity



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Use Case Development

- For each Use Case:
  - Determine Pre/Post Conditions and Event Trigger
  - Write **Normal Flow** of events
  - Write Alternate flow of events
  - Add Business Rules
  - Build/Add Glossary

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Use Case Example

Name: Withdraw Cash by Specifying Amount
Description: A bank customer withdraws cash from participating ATM

Actors: Customer , System
Pre Conditions: Customer has account at bank
Trigger: Customer wants cash
Post Conditions: Customer obtains cash and card returned

Main Success Scenario:

1. Customer inserts a card into ATM
2. System reads card, validates info and requests PIN
3. Customer enters PIN
4. System submits acct info and PIN to bank for validation
5. System responds with PIN valid
6. Customer selects to withdraw cash.
   [Alternate: Fast cash 6a]
7. System responds with Amount to be withdrawn
8. Customer enters amount
   [Rule: multiples of $10]
9. System validates requests, debits account, delivers cash
   [Rule: Daily limits not exceeded]
10. Customer takes cash and card

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Use Case Example *(cont)*

Alternate Flows of Events :

2a. System can not read card. Returns card . END

3a. Invalid PIN entered. System re-request PIN. Go TO Step 2.

5a. System responds with Acct /PIN invalid. GO to Step 2.
[Rule: 3 attempts only]

6a FAST cash.

6a1	Customer selects fast cash
6a2	System send $100
6a3	Go To Step 9

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Use Case Scenarios

- A scenario flows the user through the use case which will end in either the accomplishment or abandonment (END) of the goal
- The main scenario “success” describes the normal flow of the user with the system
- The alternates describe flows that are conditional exceptional, or errors. These flows end in either:
  - » Success
  - » Abandonment (END)
  - » Another step in the Use Case

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Rules

- Types:
  - Constraints (specific to Process NOT entire project)
  - Timeframes
  - Date events
  - Ranges/Limits
  - Sequences
  - Legal

Name/Number	Definition	Type	Source/Owner
#1	Price change on November1st	Date	Registrar
#2	MailIn Deadline – same as Price change which is November 1st	Date	Registrar
#3	Shirt Size – Medium,Large, XL	Text	Tshirt Coord

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Glossary

- An ever present list of words to ensure common usage
- The easiest trap to fall into is the creation of synonyms .

Term / Word / Name	Definition	Known Synonyms	
Data Entry	Performs key stroke service of paper application		
DataBase Admin	Administers MS Access Database	DataBase Volunteer	

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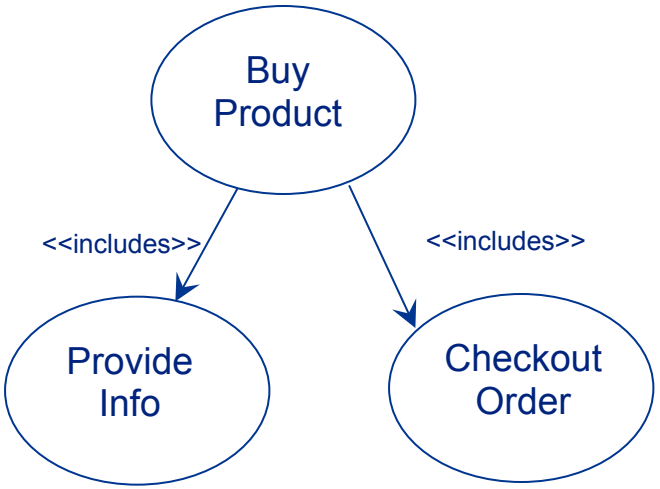
Parking Lot / Issues

- A running list of topics / ideas that need to be put aside from a current discussion
- At the end of a meeting each issue is assigned to a person to research and bring back to future meeting
- Some groups follow a 3-5 minute rule. If a topic is spun around in circles beyond the time, it is “parked”.

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Included Cases

- References other Use Cases which are common to several Use Cases
- The successful execution of an included Use Case should return to the calling Use Case.



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Example with Included Use Cases

Name: Buy Product
Actors: Customer, System
Pre Conditions: none
Post Conditions: Product purchased

Main Success Scenario:

1. Customer access system
2. Customer Provides Information
3. Customer selects quantify
   - Alternate: Continue Shopping 3a]
4. Customer proceeds to Checkout Order

Alternates:

3a Continue Shopping
3a1 Go to Step 2 .

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Exercise – Build a Use Case

Review the WPM for the Case Study

Write a Use Case for the **1.1.2 Check Fields Process**

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Class Diagram

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Discovering Classes

- Nouns from Documents
- CRC
- Context Diagrams (Actors)
- WPM
- Use Cases
- Existing ERD (Entity Relationship diagram) / Data Dictionary

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CRC (Class, Responsibility, Collaboration)

- Index cards
- Identify classes
- Assign responsibility
  - Ultimately become Method candidates
- Determine collaboration
  - Ultimately will be classes using other classes

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Steps to create CRC

1. Write the name of a potential Class on an card
2. Review cards , organize and combine
3. Identify what each class is responsible for doing / maintaining
4. Identify other classes that each class might need to interact

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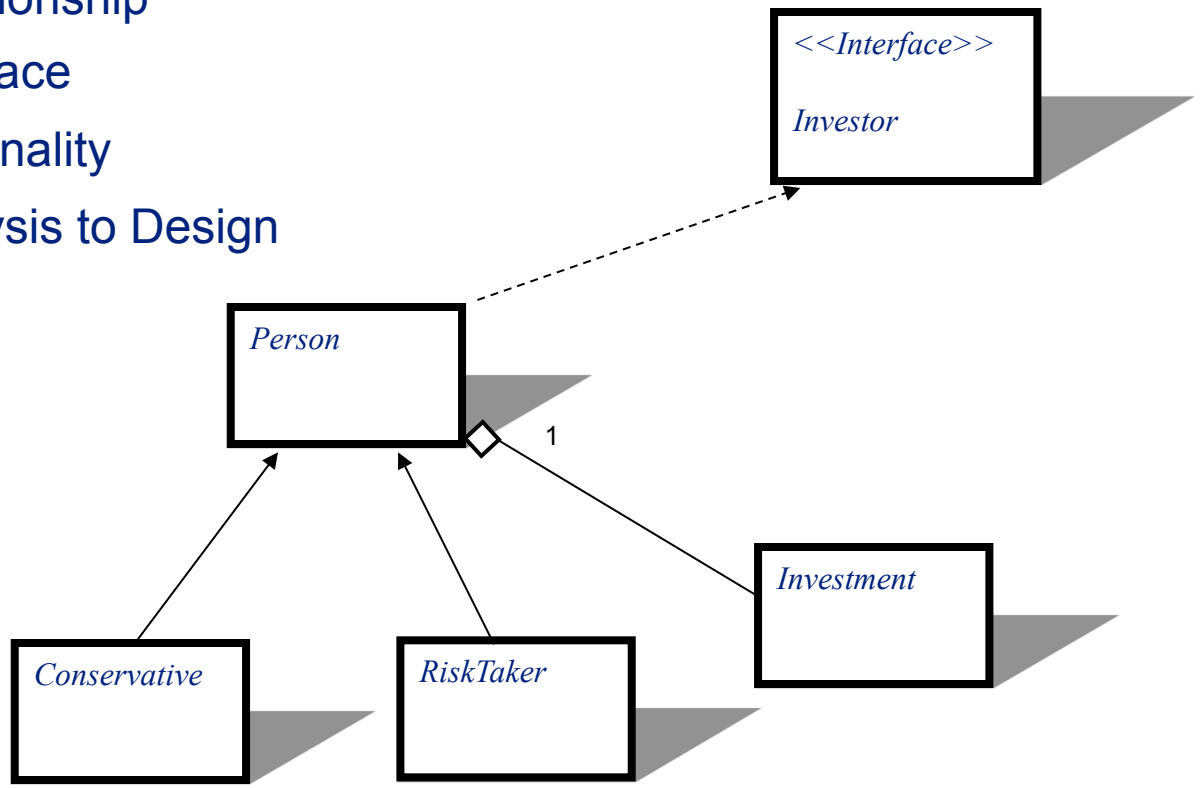
CRC Example

Person	
Calculate Time Register for race Print	Results Credit Card Printer

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Class Diagram Notations

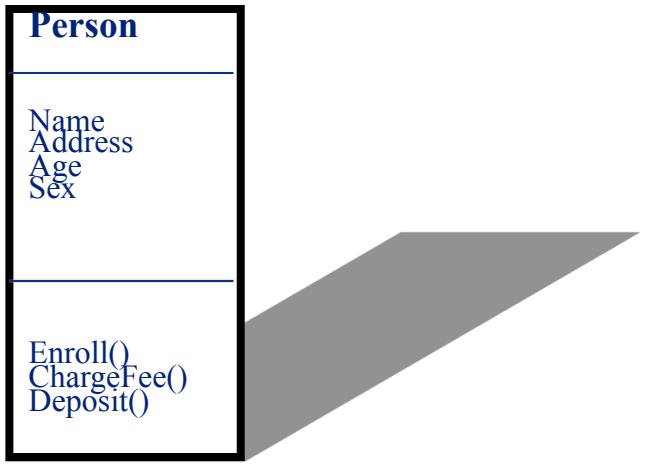
- Inheritance
- Aggregation / Composition
- Relationship
- Interface
- Cardinality
- Analysis to Design



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Class Representation

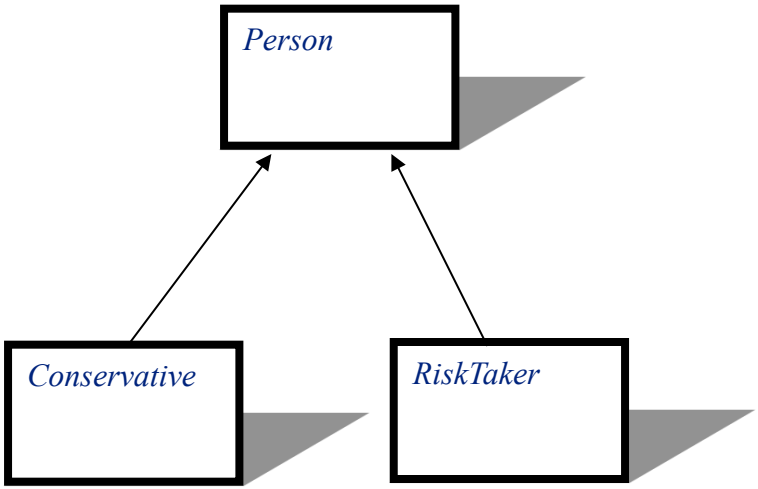
- Name
- State / Attributes / Properties / Fields / Data
  - What embodies a Person ?
- Behavior / Methods / Functions
  - What can a Person do ?



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Inheritance

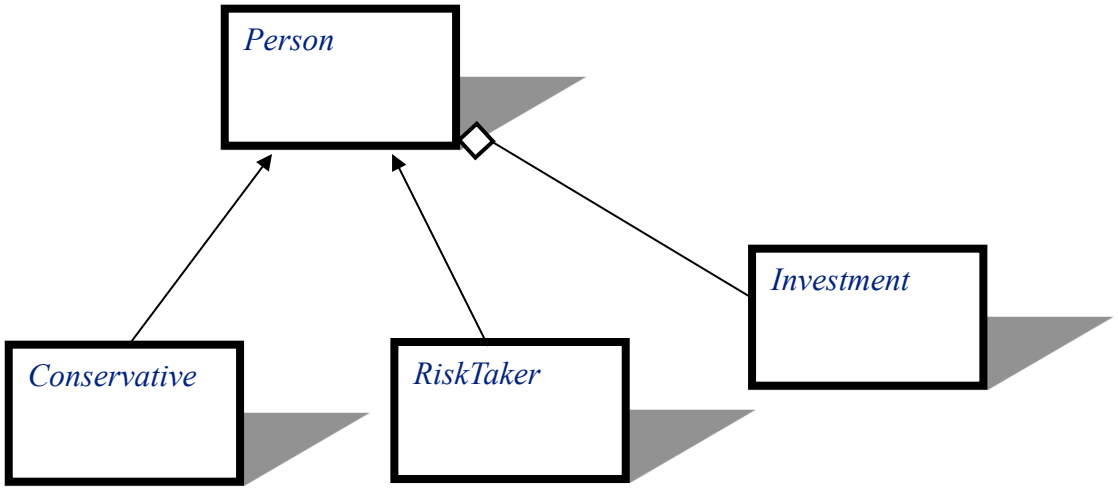
Represents that a Class “Is-A” type of another class.



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Aggregation

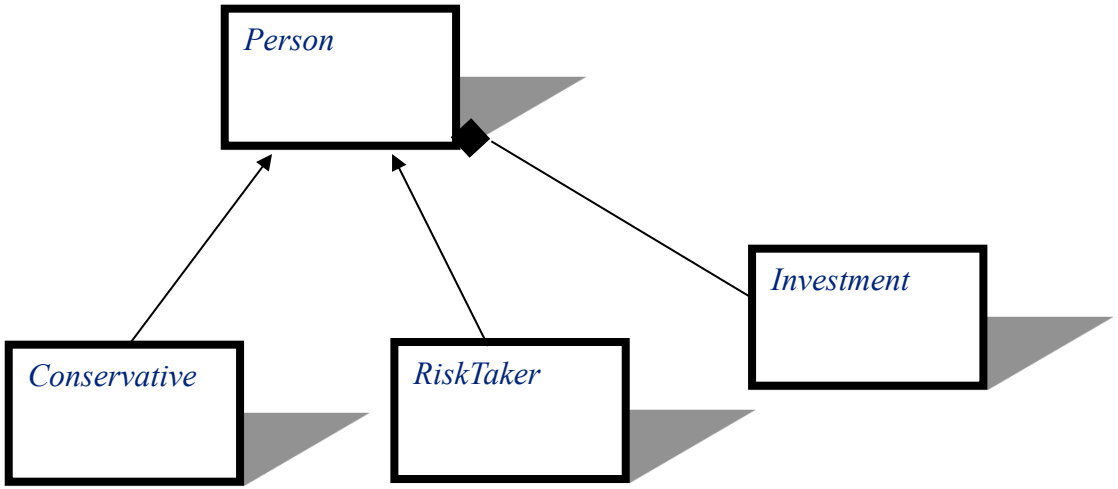
- The Investment class is contained in the Person “Has-A” and there are ONE or MORE Investments
- Within a language the Investment would be an ArrayList of some kind



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Composition

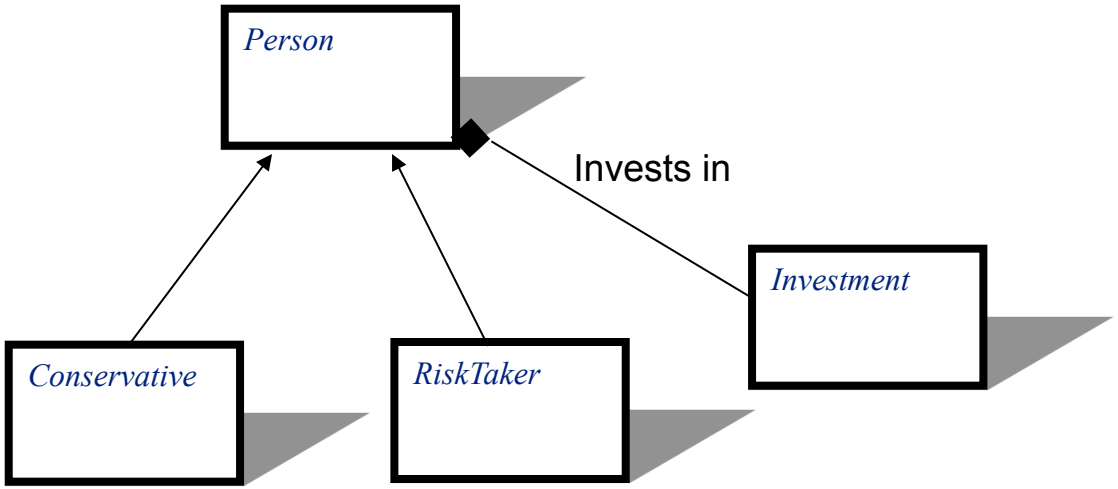
- A very subtle distinction with Aggregation
- The Investment class only has meaning when associated with a Person. It doesn't stand alone. Would it make sense to have an Investment NOT associated with a Person



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Relationship

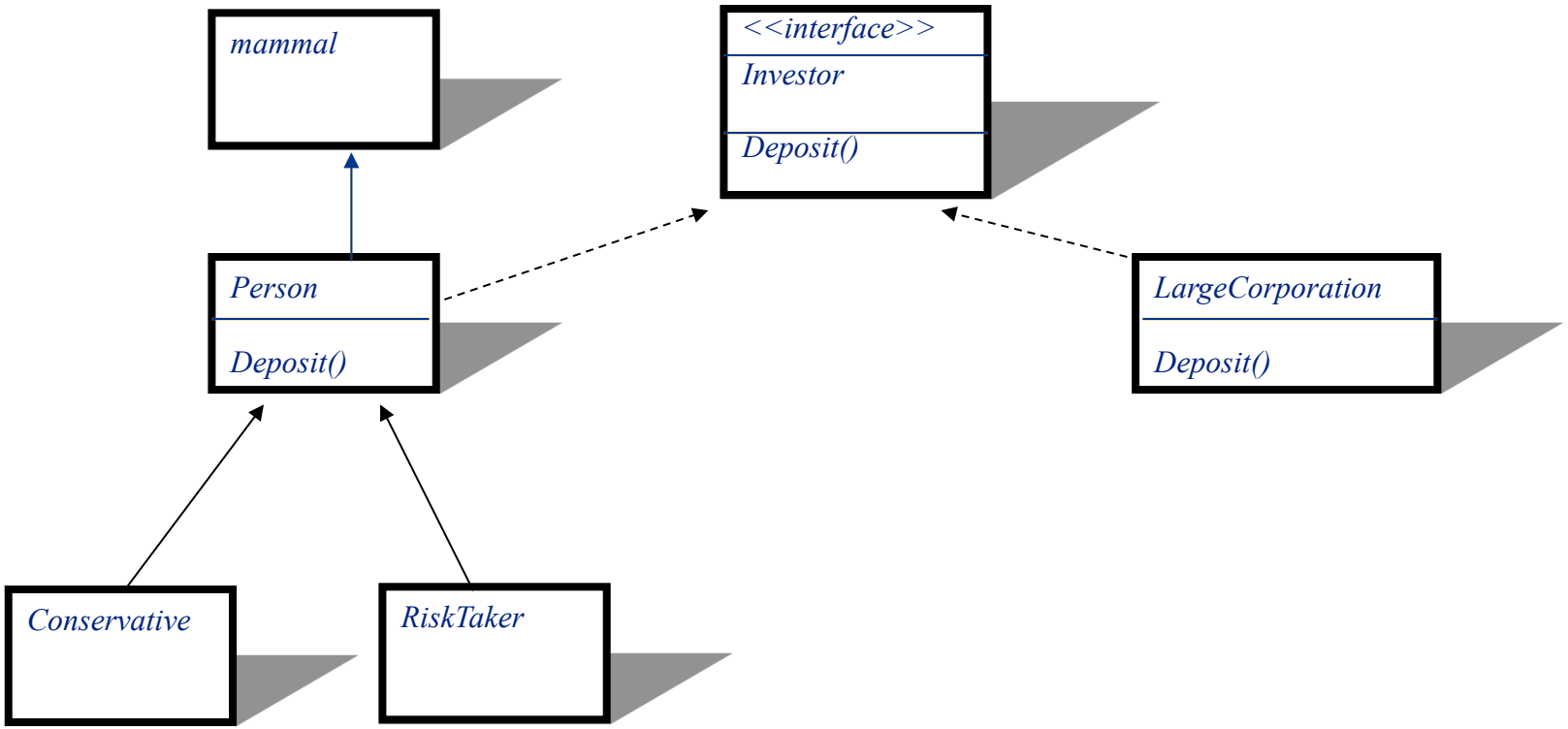
- Assign meaning where necessary
- A Person “invests-in” an Investment.



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Interface

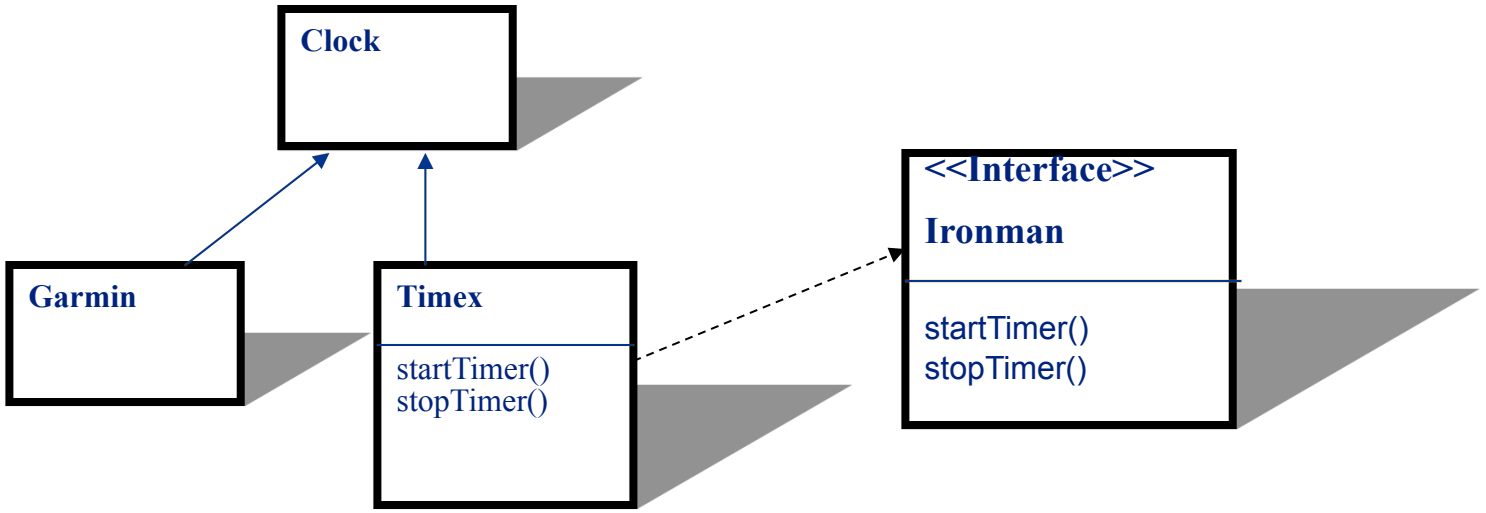
- Since multiple inheritance is rarely available, the concept of an Interface was developed
- An interface provides a “kind-a-like-a” relationship
- In this example, a Person is “kind-a-like-a” Investor. The Person is enough like an Investor in that it is able to perform Deposit() method
- The Person MUST implement a method called Deposit() since Deposit is a method signature defined in the Investor Interface



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Interface - Example

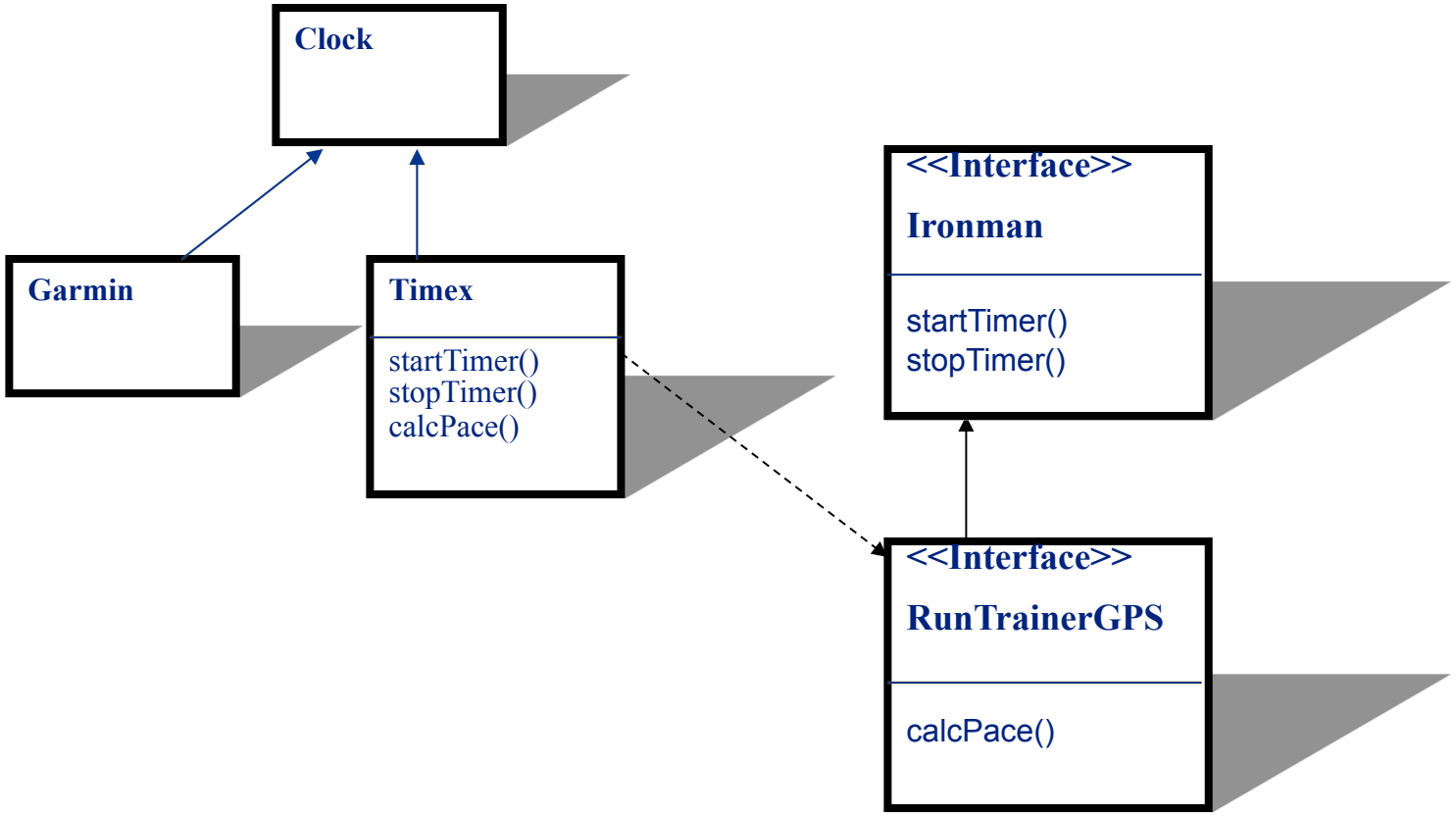
- A Timex watch “Is-A” clock.
- The Ironman interface assures that the startTimer / stopTimer methods exist and are implemented by the button in the upper right hand corner of the watch.



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Interface - Example

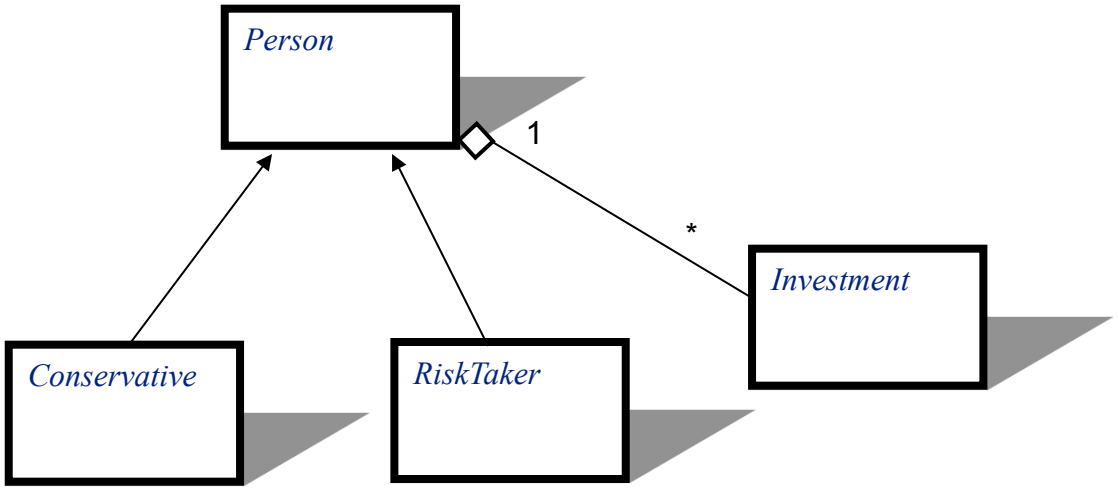
- A Timex watch “Is-A” clock
- The RunTrainerGPS interface assures that the startTimer / stopTimer methods exist and are implemented by the button in the upper right hand corner of the watch
- This watch must also calculate Pace(minutes / mile)



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Cardinality

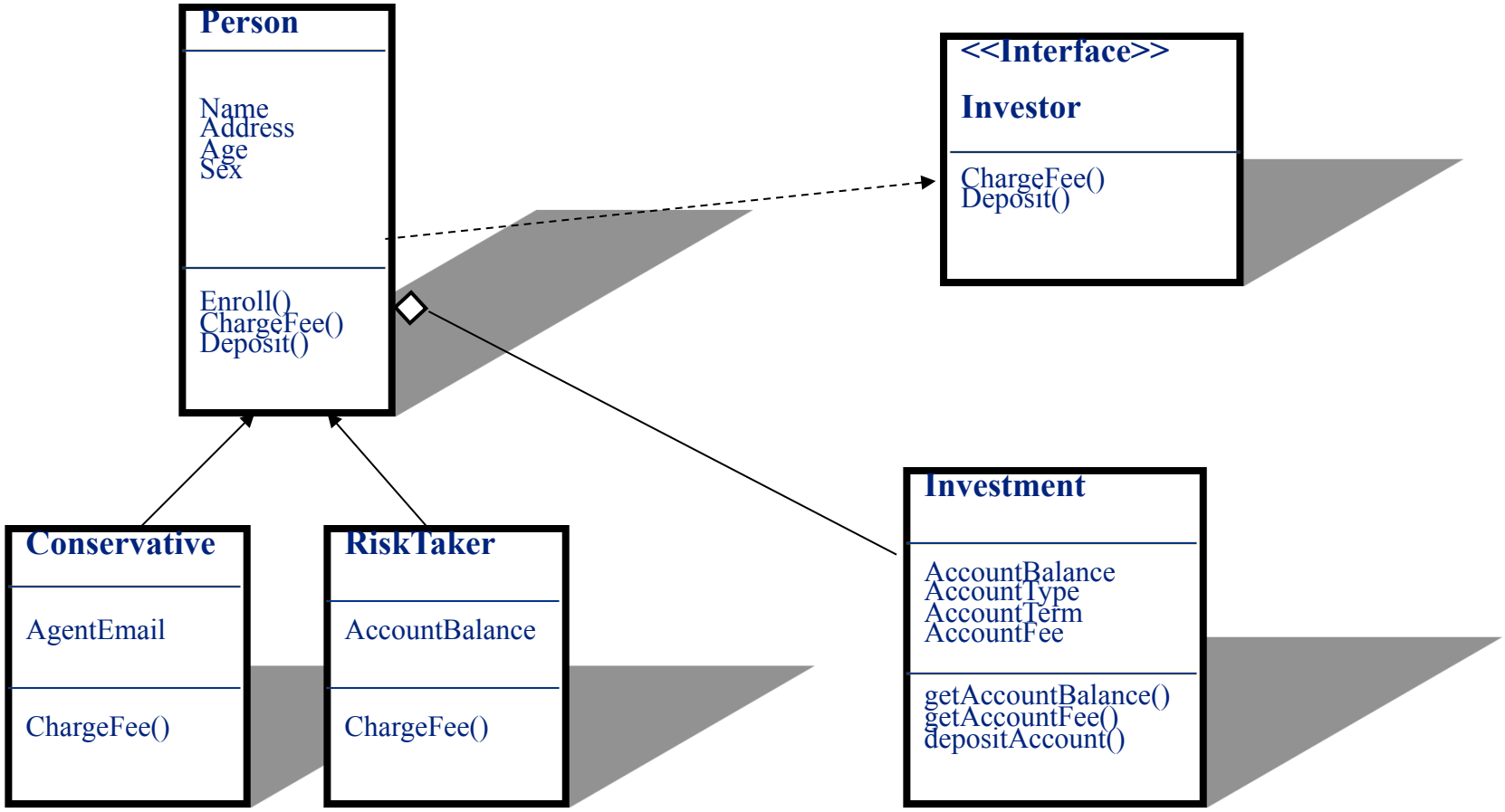
- Meaning can be added to some relationships by giving an indication as to the number of occurrences that can exist.
- Notations:
  - n … indicates number of occurrences
  - * … infinite
- In the example below, an Investment can only be possessed by ONE Person but a Person can have many investments



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Analysis Level – *First pass*

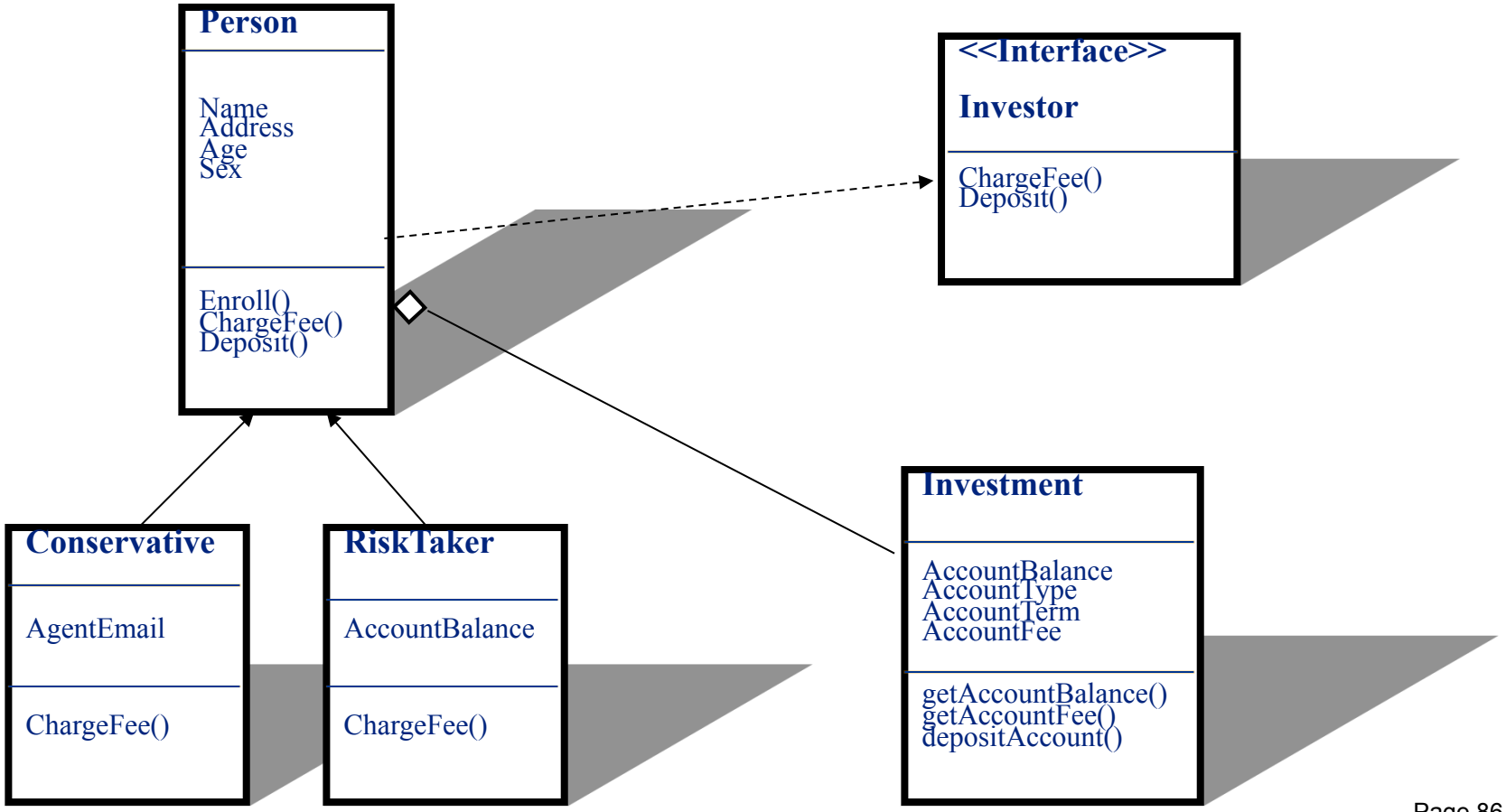
- You are probably done when you have captured much of the information from the CRC



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Analysis Level – *Second pass*

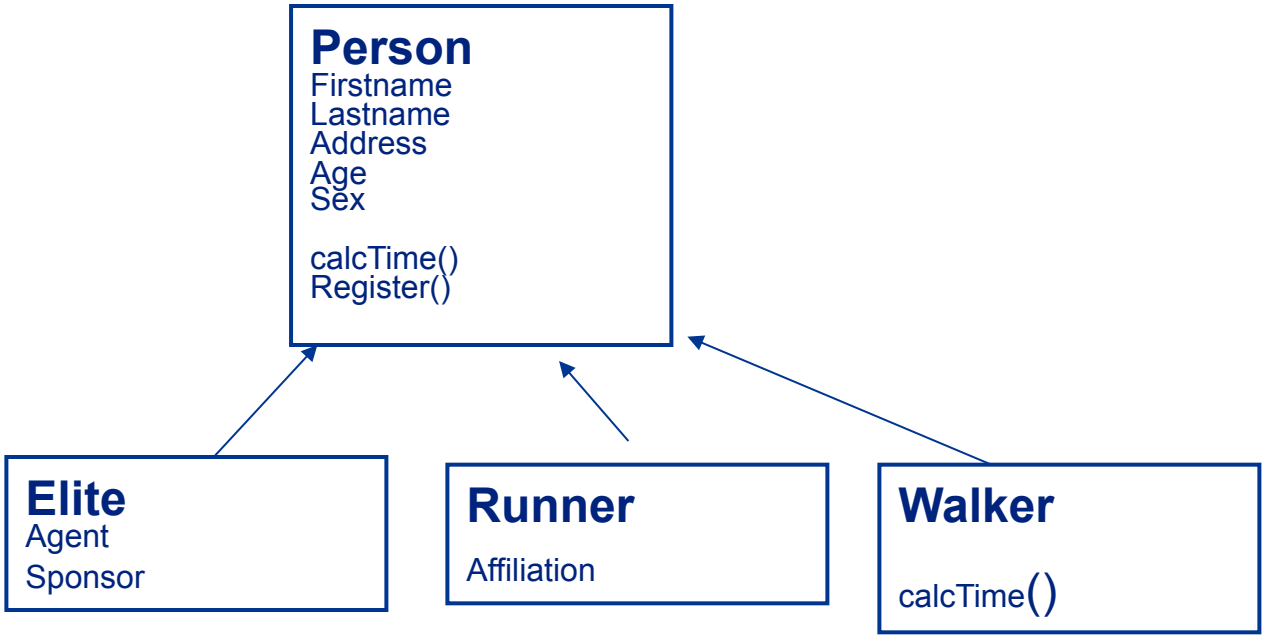
- Review requirements to ensure that you have captured enough of the properties and methods to implement the Classes
- If you have done some Use Cases then use them to"walk through" and validate the Class Diagram
- For example:
  - A RiskTaker would like to invest $300 into an Investment



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Exercise

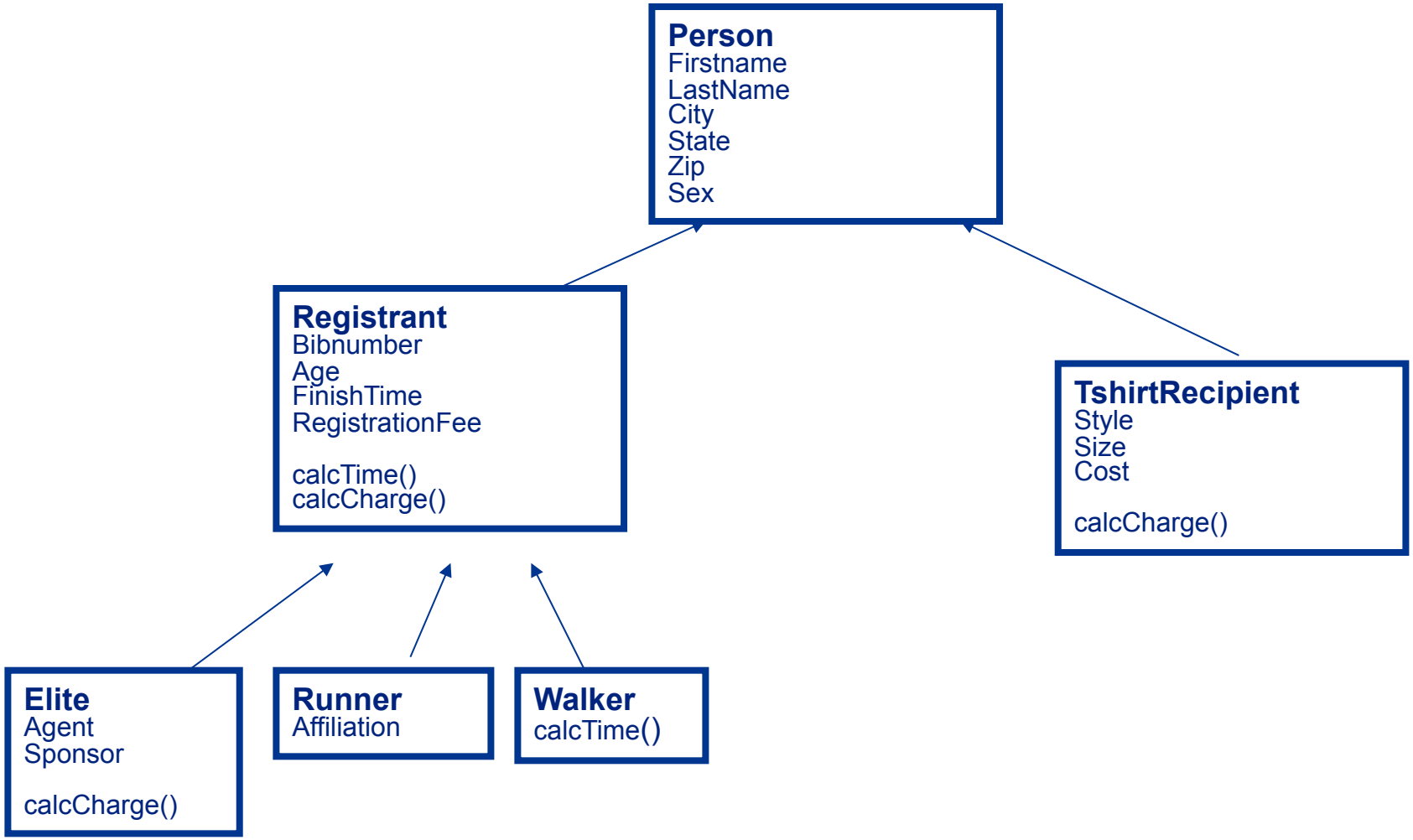
Expand the diagram to include Tshirt Sales. Look at the registration form in the Case study



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Exercise

Manipulate the diagram to all for the sale of Books, Neck-ties and Dance Tickets




```
foreach (Person pers in ShoppingCart)
    pers.calcCharge();
```


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Design

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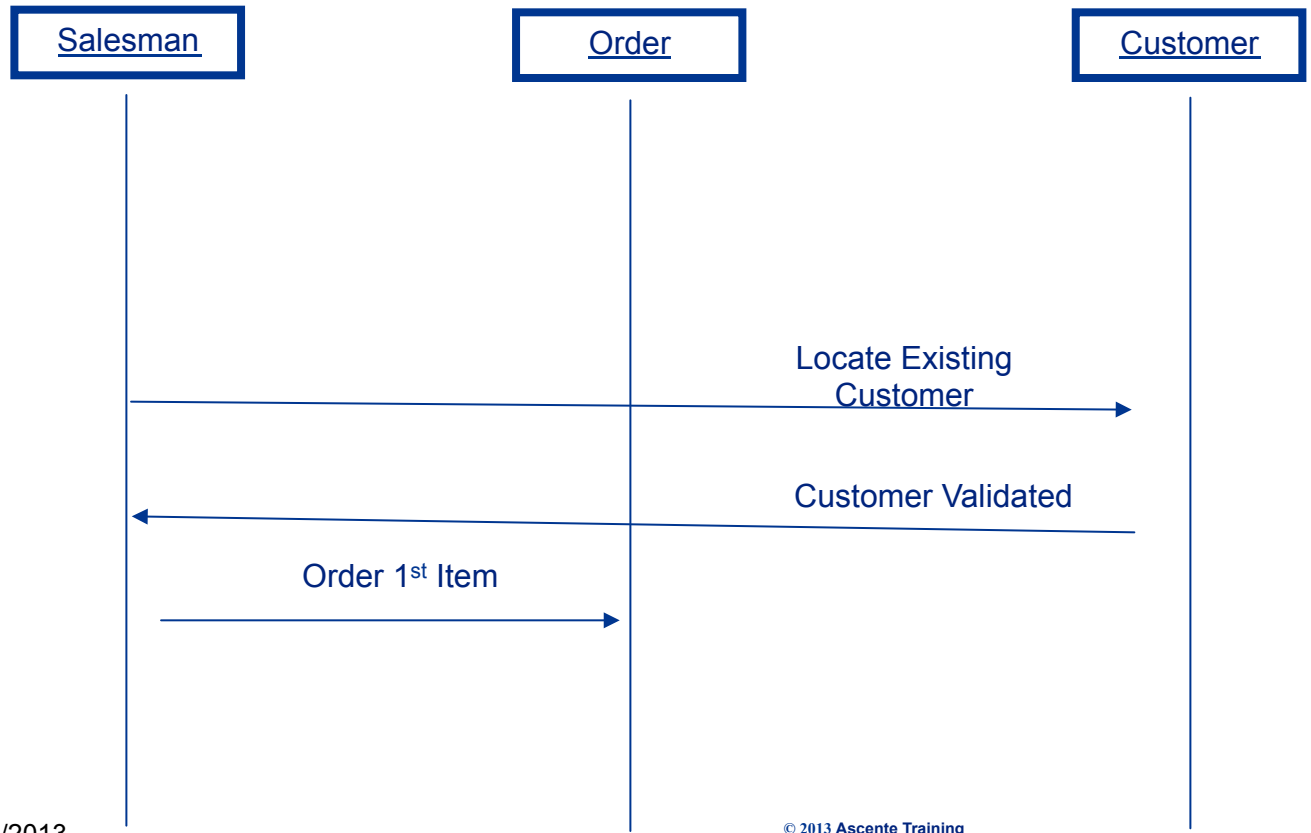
Deliverables from Design

- Sequence diagrams
- Class diagrams in detail
- Design Patterns
- Data Base Interface

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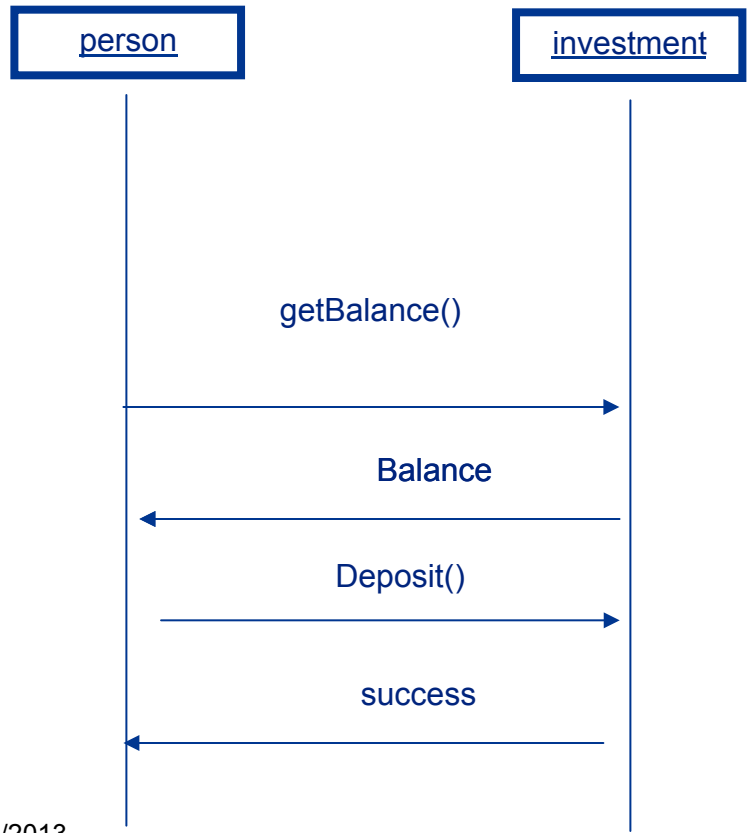
Sequence Diagram

- Shows classes involved in scenario
- Sequence of messages among objects



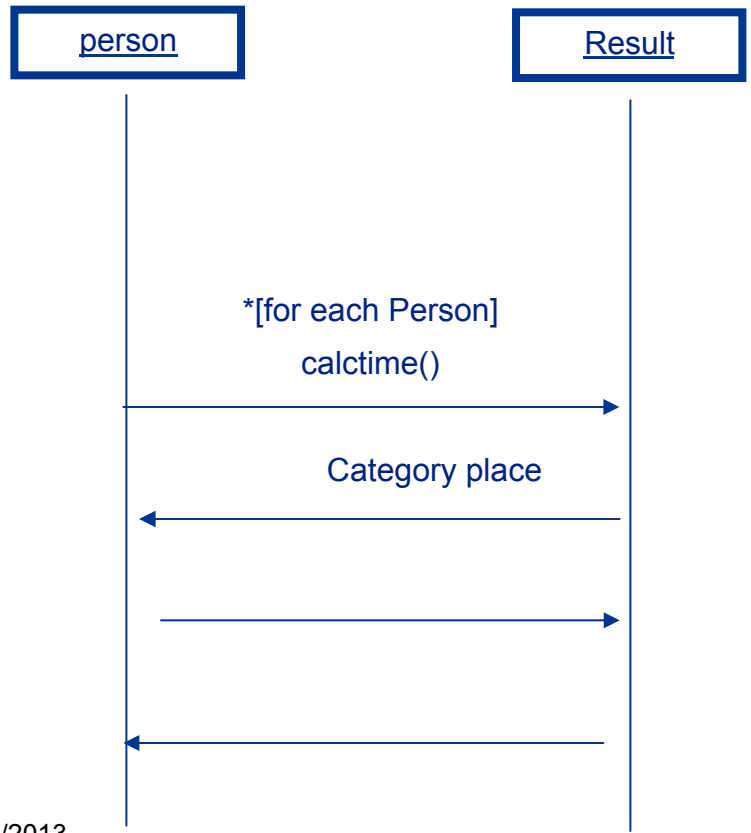
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Sequence Diagram - *Example*



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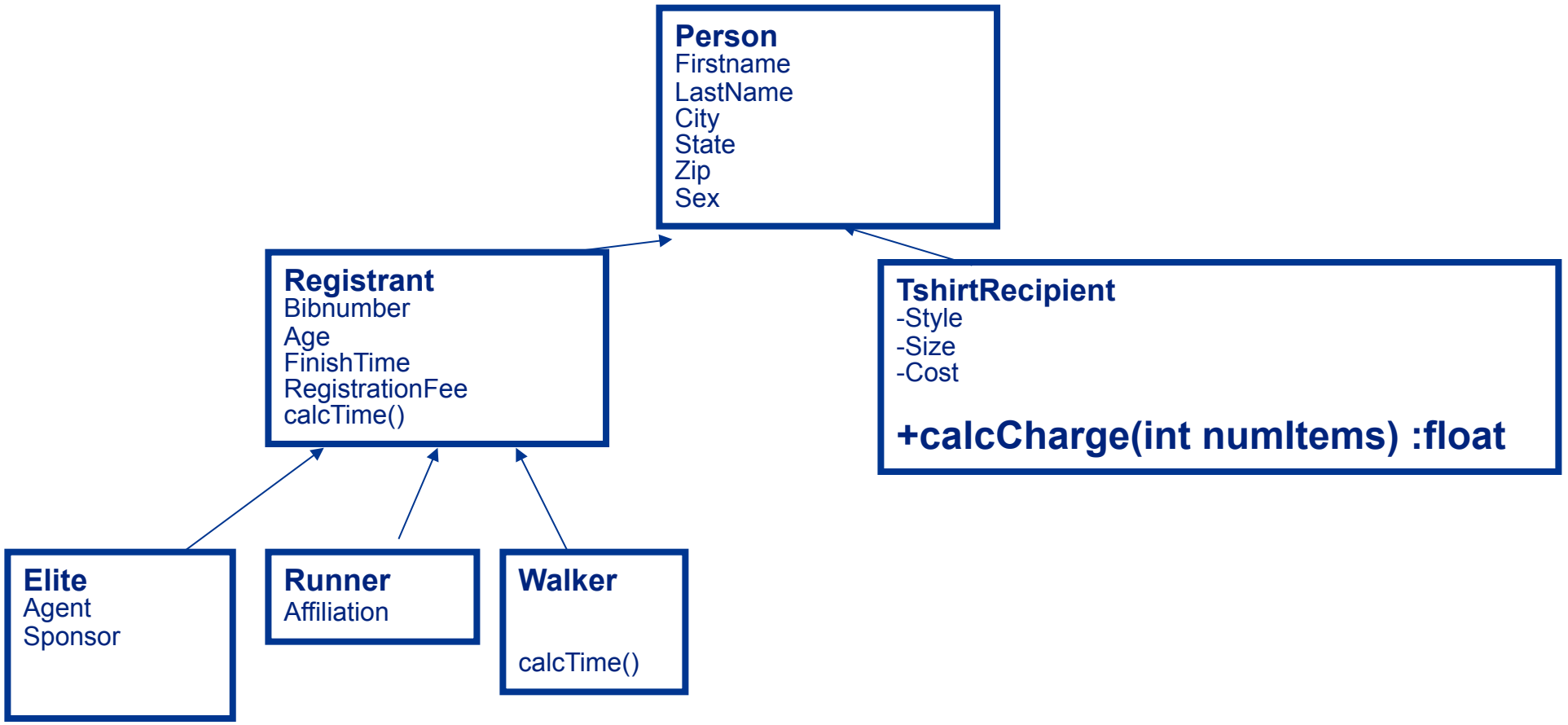
Sequence Diagram - *Example*



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Class Diagram – Design

- Added detail will indicate scope of data and method signatures



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Design Patterns

- Represent consistent models to accomplish a variety of tasks

  - Creational
    - Abstract factory
    - Builder
    - Factory
    - Prototype
    - **Singleton**

  - Structural
    - Adapter
    - Bridge
    - Composite
      Façade
    - Proxy

  - Behavioral
    - Command
    - Iterator
    - Observer
    - State

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Singleton Pattern

- Indicates that only ONE instance of this class can/should be instantiated

- For example, a class that connects to a database. If multiple instances existed, then multiple connections to the database would exist, causing performance and concurrency problems.



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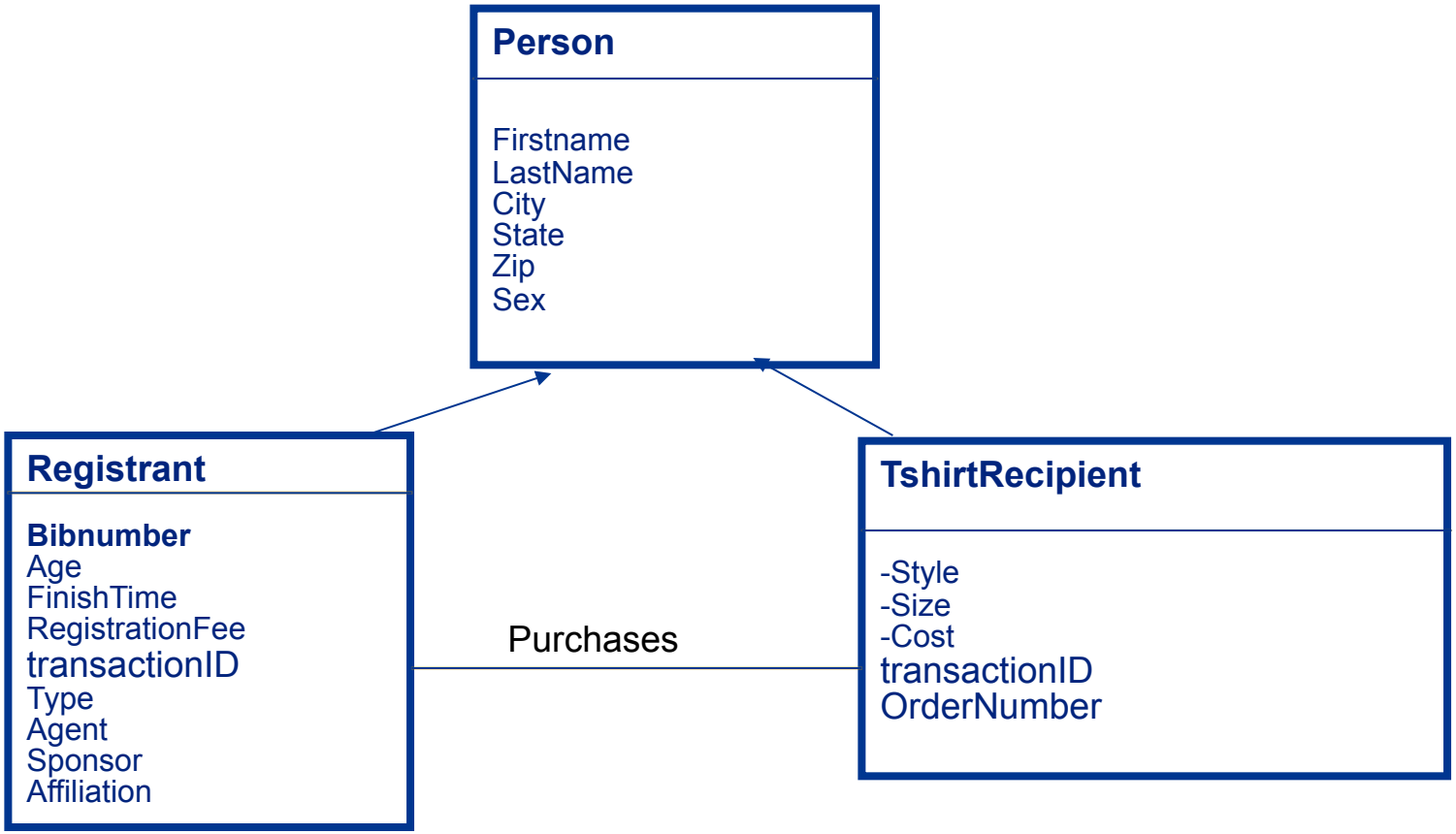
DataBase Realities

- Relate to Class diagram
  - Primary / foreign key
  - M:M relationship
  - Only data - No mechanism to capture methods

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Entity Relationship Diagram (ERD)

- Analogous to Class diagram
  - Primary / foreign key
  - Associative / Junction Tables

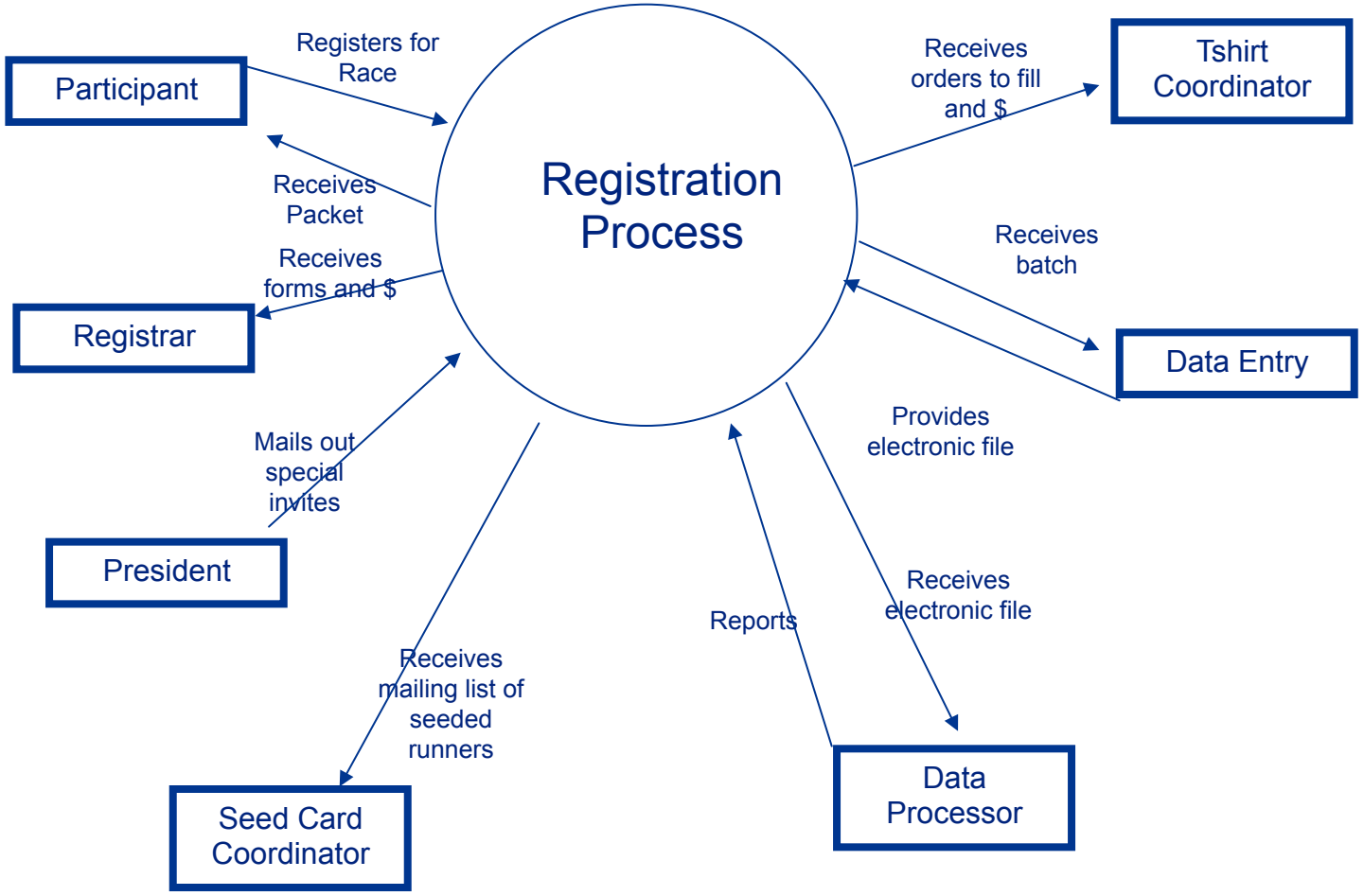


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- Examples
- Test Case Translation

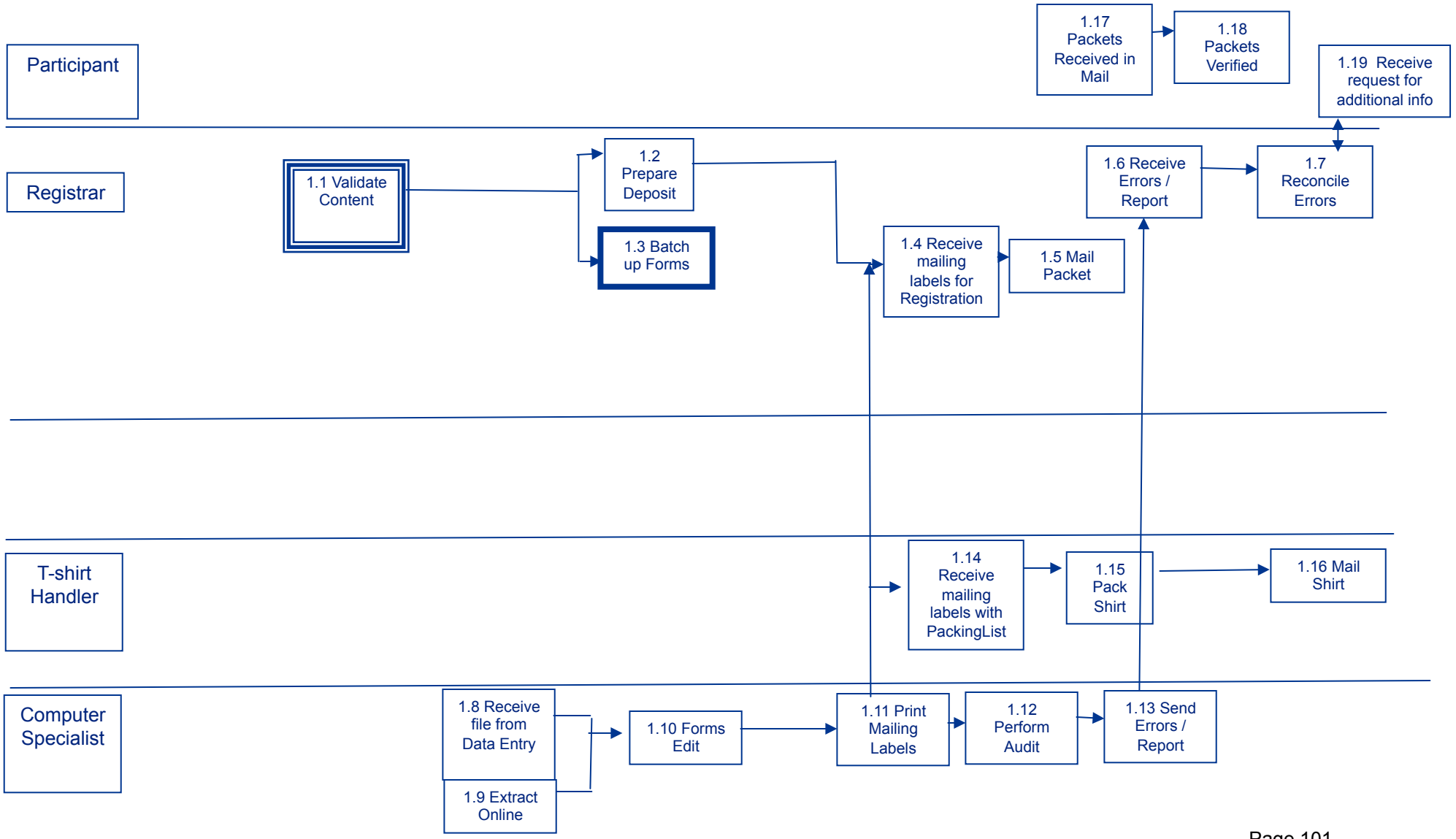
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Context Diagram FRR – “As Is”



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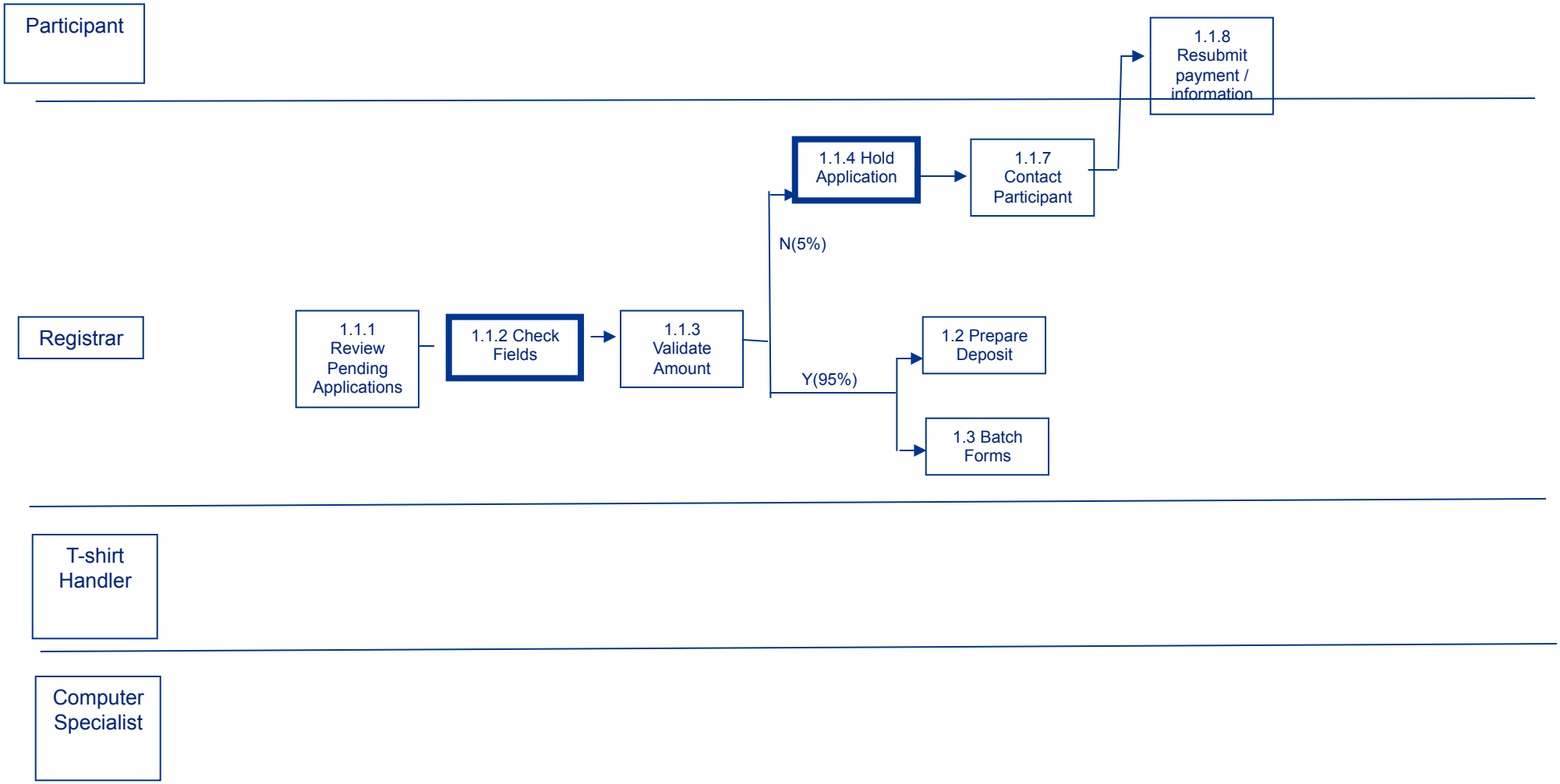
WPM Level 1



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WPM Level 2

Validate Contents



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Use Case

- 1.3 Batch up Forms
  - Description
    - Validated Forms are grouped in batches of 200, noted in audit log and brought to Data Entry
  - Actor(s)
    - Registrar
  - PreCondition
    - A registration count is established and forms processed for data entry
  - PostCondition
  - Main Success Scenario

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Use Case

- 1.1.2 Check Fields
  - Description
    - Determine that all required fields are entered . Provide default values where appropriate. Tally the expected amount of payment.
  - Actor (s)
    - Registrar
  - Pre Condition
  - Post Condition
    - Money tallies are appropriate and data fields are edited and defaulted
  - Main Success Scenario

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Test Cases

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Types of Tests

- Unit – new functionality works
- Integration – new functionality works with existing system
- Regression – existing functions continue to work
- Performance – functions can meet Service levels
- Stress – functions can handle loads
- Security – intruders rejected
- Usability – functions delivered in an acceptable manner from user's point of view

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Relationship with Use Case

- Use Cases are one of the best forms of documentation that a test team can receive. Primarily because the Use Case contains normal flow and exception/alternate flow processing
- At least one test case per Use Case extension (alternate path) and one test case for Success Scenario.
- Additional test cases for data values and permutations of wrong scenarios
- The test team must create a setting to trigger the different paths through the Use Case
- Performance tests varying load would be part of any test plan but not derived from Use Case

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Test Case Model

- For each Test Case define:
- **Initial System Inputs**: This is the set of values that the system knows before the start of this use case . These values are derived from the preconditions for the use case.
  - TM ***Customer: Withdraw Money – Success***
  - Account 101 with balance $1100.00
  - ATM contains 10 - $20 bills.

- **Expected outputs**: The set of values that the system will contain after the use case has completed. The values for the final state are derived from the Post Conditions.
  - ATM ***Customer: Withdraw Money – Success***
  - Account 101 with balance $1100.00 and pending withdrawal of $60 from ATM
  - ATM contains 7 - $20 bills
  - receipt shows withdrawal of $60 from account 1** with a remaining balance $1040.00.

- Note: Examples taken from Pet McBreen (www.mcbreen.ab.ca/papers)

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Test Plan Example – Use Case

- **Buy goods**
- **Description**
- Customer places order for goods, an invoice is generated and sent out with the ordered items.
- **Main Success Scenario**
  1. Customer Selects items and quantities
  2. System Allocates required quantities to customer
  3. System Obtains authenticated invoicing authorization
  4. Customer Specifies shipping destination
  5. System Sends picking instructions to distribution
- **Extensions**

  2a Insufficient stock to meet required quantity for item
  2a1 Customer confirms reduced quantity

  2b Out of stock on item
  2b1 System determines shipping date
  2b2 Customer Accepts delayed delivery

  3a Customer is bad credit risk

  4a Invalid shipping destination

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Test Plan Example

- **Main Success Scenario**
  - *Initial system inputs*
    - Customer Fred (Good Credit risk) orders 1 of item#1 price $10.00
      quantity on hand for item#1 is 10
  - *Expected system outputs*
    - Quantity on hand for item#1 is 9
      Delivery instructions generated
      Invoice generated for Customer Pete for 1 of Item#1 price $10.00
- **Bad Credit risk**
  - *Initial system inputs*
    - Customer Joe (Bad Credit risk) orders 1 of item#1 price $10.00
      quantity on hand for item#1 is 10
  - *Expected system outputs*
    - Quantity on hand for item#1 is 9
      Delivery instructions specify Cash on Delivery

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Appendix B - References

- *UML Distilled* , Martin Fowler, Addison-Wesley, 2000
- *Workflow Modeling*, Alec Sharp and Patrick McDermott, Artech House Publishers, 2001
- *Writing Effective Use Cases* , Alistair Cockburn , Addison-Wesley, 2001
- *Requirements by Collaboration*, Ellen Gottesdiener , Addison-Wesley, 2002
- *Mastering the Requirements Process* , Suzanne Robertson and James Robertson, Addison-Wesley,2006
- *Business Analyst Book of Knowledge* , International Institute of Business Analysis , www.theiiba.org
- Software Requirements , Karl Wiegers , Microsoft Press , 2003

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Case Study - Workshop

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Farmingdale Road Race(FRR) Registration System *(page 1 of 2)*

The FRR hosts over 11,000 runners on Thanksgiving Day in Farmingdale, CT. For each of the last several years of its 70+ year history, the race proceeds to charity have exceeded $100,000. Each of the participants has registered either through the mail or in person during Walk-in registration which occurs for the 3 evenings before the race.

Registration costs $20 before the cutoff date (3 weeks before the race) and $25 after this date. T-shirts can be purchased at time of registration.

Money for registration and T-shirts is deposited into the road race bank account and a note is sent to the treasurer indicated the number of registrations and T-shirts purchased for a given batch that has been processed by the registrar. The treasurer is audited yearly and must be able to account for total number of runners, total number of sold T-shirts and balance these with deposited funds.

Data entry for the mail in registrations is provided by a professional service and works very well.

All registrations are mailed to a PO Box which is emptied regularly by the registrar. Typically a participant sends in one registration form with an attached check. Sometimes an entire family may register and send individual checks or one check for total amount. Since T-shirts can be purchased, the check may include that order also.

The registrar opens the envelop, scans the form(s) for completeness and validates correct amount of check. Forms are placed in one pile and checks in another. Total number of registrations and total T-shirt request are tallied. The checks are totaled and prepared for deposit. In batches of 200, the registration forms are sent to data entry. This is a professional service that keystrokes the forms into an electronic file which is then emailed to the DataBase volunteer.

The DataBase volunteer uploads the file into a MicroSoft Access database and runs several programs which edit the data and assign a bibnumber to the participant. The data edits check for missing fields such as address, age and birthdate. Also a cross field check is performed between age and birthdate. Incomplete or inaccurate information will need the attention of the registrar to correct. Several demographic reports, mailing labels for all participants, category winners and participants designated as walkers can be produced. The updated database is then emailed to the Registrar and Tshirt coordinator who can then print mailing labels (see Appendix E)

The registrar prints the next set of mailing labels in bibnumber sequence. She has already prestuffed and sealed the envelops which contain the bibnumber,timing chip and letter of instructions to the participant. These envelops are numbered sequentially with the number on the outside of the envelop matching the bibnumber and chip that has been placed in the envelope. Once she prints the labels it is then just a simple process of affixing the proper label to the envelop. Note: One unique feature of the FRR is that the registration packet is are mailed to a registered participant who registers before the deadline in November approximately 3 weeks before the race. Easily 9,000 people receive their packets in the mail before the race.

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Farmingdale Road Race(FRR) Registration System *(page 2 of 2)*

The Database Volunteer maintains the "production" data. Prior to race day this data contains the registration data and tshirt orders. At 11pm on Wednesday night before the race the registration data is emailed to the timing services company. This is needed for race results which are printed in the newspaper 2 days after the race. Then in August of the next year the registration data is used to create mailing labels for next year's mailing of the brochure.

A separate mailing which includes a short letter and registration form(See Appendix E) goes out to some "special people" and category winners from the previous year who have their fees waived. The goal is to have mailed this before the standard brochure is mailed.

The Problem

The registrar is overwhelmed with the shear mass of mail in forms. Several attempts to use an online system have helped relieve the mail-in volume but have caused no end to questions, concerns from people who use the system, and frustrations for the registrar. The volume of emails has grown tremendously.

Goal

Develop the Business requirements for an online registration system that will integrate with the current Mail-in Registration Process. The road race committee should be able to hand these requirements over to any web site company and get a system that meets expectation. The look and feel (screen design) is NOT that important to the committee. The frustration lies with misunderstanding and misinterpretation.

Recent activities

An online registration company can provide a website link to allow registrants to enter all pertinent information. They will also host the RoadRace website and do this for a very reasonable fee. In fact some of their fee will be waived if they are featured prominently on the website. In addition to registration information, T-shirts can also be purchased. The service will provide direct deposit of funds into the FRR bank account after deducting their handling fee of $1.00 per each transaction.

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REGISTRATION FORM

Different Ways to Register

On-line:
At www.FarmRoadRace.com (plus handling fee) from September 1st thru November 20th.

By Mail:
Applications will be accepted by mail from Sept 1 thru Nov 9th. Return envelope and postage will be supplied by the Road Race. All out of country registrations must be picked up.

Walk-In:
Registrations will be held at Bennett Middle School, 1151 Main Street in Farmingdale

Saturday	Nov 22	8:30 am to Noon (Sports Expo)
Monday	Nov 24	6:00 pm to 9:00 pm
Tuesday	Nov 25	6:00 pm to 9:00 pm
Wednesday	Nov 26	6:00 pm to 9:00 pm

NO RACE DAY REGISTRATION

NO REFUNDS

Entry Information

Entry Fee:
$20 for Mail Entries postmarked by Nov 9th
$25 for all entries thereafter
T-shirts and race fees may be paid for with one check or separate checks.

Make checks payable to:
Farmingdale Road Race Committee, Inc.
(Do not staple check)

Mail to:
Farmingdale Road Race
P.O. Box 211
Farmingdale ++ CT 06045-0211

Notes:
1) College students, please use your home address
2) Use **C/O** and your last name when registering person's not recognized by the USPS to receive mail at your address
3) Each registration is mailed singly in its own separate envelope
4) Tshirts, if purchased, are mailed separately and may arrive on a separate day

Participants who register before November 9th will have their packets mailed to them. The packet of information will include a timing tag, bib number, and race instructions. Just show up the day of the race and run.

Participants who register after November 9th must pick up their packets during Walk-In registration. All registrations can be verified on our website to ensure that we have you properly listed in our registration file. Race day packet pickup will be available from 8:00am to 9:15am in Bennett Middle School (Be advised this is very chaotic and there is no opportunity to handle questions/concerns)

(Please cut along dotted line)

E-mail _____ OFFICIAL USE ONLY

Last Name First Name M.I.

Address *(for packet mailing)*

City State Zip

Country Phone

Sex M F Age (on race day) Birthdate M M D D Y Y Y Y Walker

T-shirts to purchase: **Short sleeve** Medium Large X-Large ($17 each)
Long sleeve Medium Large X-Large ($24 each)
Check here if this is a Tshirt ONLY purchase

Waiver 2008
I know that running a road race could be a hazardous activity and that I should not run unless I am medically able and properly trained. I ASSUME ALL RISKS ASSOCIATED WITH RUNNING THE Farmingdale THANKSGIVING DAY RACE, INCLUDING BUT NOT LIMITED TO FALLS, TRAFFIC AND CONDITIONS OF THE ROAD, ALL SUCH RISKS BEING KNOWN AND APPRECIATED BY ME. Having read this waiver and knowing these facts and in consideration of your accepting my entry, I, for myself and anyone entitled to act on my behalf, hereby waive and release the Farmingdale Road Race Committee, Corporation, Pratt & Whitney Foundation, the US Track & Field, and all sponsors, volunteers and providers of services to the race, their representatives and successors from all claims or liabilities of any kind arising out of my (or entrant's) participation in this event even though the claim or liability may arise out of negligence or carelessness on the part of any person named in this waiver.

_____
SIGNATURE (Signature of parent or guardian if entrant is under 18 years old) DATE

Mailing Label Examples

- Registration Mailing Label *(There are 30 of these per sheet)*

- Bib# 2 Sex: Male Age 61
- AMBY BURFOOT
- 7 xxxxx ST
- EMMAUS, PA 18049

- Tshirt Mailing Label *(There are 10 of these per sheet)*

- KEN SMITH
- 7 CLIFF DR
- ELLINGTON, CT 06029
- Med Large X-Large
- Short 0 0 0
- Long 1 0 0
-
- Order # 3

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