Table of Contents

[Chapter 1 Introduction 11](#_Toc355723099)

[1.1 Topic of the System 11](#_Toc355723100)

[1.2 Purpose of the Situation 11](#_Toc355723101)

[1.3 Target User of the System 13](#_Toc355723102)

[1.4 Topic Background 13](#_Toc355723103)

[1.5 Problem Context 14](#_Toc355723104)

[1.6 Description of the Problem Area 15](#_Toc355723105)

[1.7 Rationale behind the System 16](#_Toc355723106)

[1.8 Project Objectives 18](#_Toc355723107)

[1.9 Academic Objectives 18](#_Toc355723108)

[1.10 Traceability Matrix between problems and functionalities 19](#_Toc355723109)

[1.11 Assumptions 19](#_Toc355723110)

[1.12 Success Criteria 19](#_Toc355723111)

[1.13 Project Scope 20](#_Toc355723112)

[1.14 Limiting the Project Scope 20](#_Toc355723113)

[1.15 Functionalities of the System 21](#_Toc355723114)

[1.16 Feasibility Analysis 22](#_Toc355723115)

[1.17 Project Planning 23](#_Toc355723116)

[1.18 Ethical Issue 24](#_Toc355723117)

[Chapter 2 Problem Description 25](#_Toc355723118)

[2.1 Introduction to Problem Area 25](#_Toc355723119)

[2.2 Problems Identified 25](#_Toc355723120)

[2.3 Problem Importance and Justification 25](#_Toc355723121)

[2.4 Challenges in the Project 26](#_Toc355723122)

[2.5 New Concepts, Theories and Technologies to be learnt 26](#_Toc355723123)

[Chapter 3 Literature Review 28](#_Toc355723124)

[3 Literature Review 28](#_Toc355723125)

[3.1 Advanced Preliminary 28](#_Toc355723126)

[3.3 Depth of Secondary Research 30](#_Toc355723127)

[3.5 Research on Similar Systems 32](#_Toc355723128)

[3.5 Quantitative and Qualitative Matrix 34](#_Toc355723129)

[3.6 Market Value of the Project 34](#_Toc355723130)

[Chapter 4 Research Methods 36](#_Toc355723131)

[4.1 Primary Research 36](#_Toc355723132)

[4.1.1 Questionnaires 36](#_Toc355723133)

[4.1.2 Interviews 37](#_Toc355723134)

[4.2 Secondary Research 37](#_Toc355723135)

[4.2.1 Technical Research 37](#_Toc355723136)

[4.2.1.1 Programming Language Research 38](#_Toc355723137)

[4.2.1.1.1 Visual Basic, Java and C++ comparison based on project 38](#_Toc355723138)

[4.2.1.1.2 Reasons for choosing Visual Basic .NET for Beacon 39](#_Toc355723139)

[4.2.1.1.3 Packages to be used 40](#_Toc355723140)

[4.2.2 Methodology: Advanced Waterfall 41](#_Toc355723141)

[4.2.21 Description 41](#_Toc355723142)

[4.2.2.2 Justification 41](#_Toc355723143)

[4.2.3 Algorithms: Why Particular Algorithm? 42](#_Toc355723144)

[4.2.3.1 Reasons for choosing Genetic Algorithm for Route Planning 42](#_Toc355723145)

[4.2.3.2 Reasons for choosing Bin Packing Algorithm for Load Planner (CLP) 43](#_Toc355723146)

[4.3 Academic Research 44](#_Toc355723147)

[Chapter 5: Research Analysis 45](#_Toc355723148)

[5.1 Questionnaire Analysis 45](#_Toc355723149)

[5.1.1 Questionnaire Conclusion 45](#_Toc355723150)

[5.1.2 Recommendation 45](#_Toc355723151)

[5.2 Interview Analysis 46](#_Toc355723152)

[5.2.1 Interview Conclusion 46](#_Toc355723153)

[5.2.2 Recommendation 46](#_Toc355723154)

[5.3 Traceability Matrix for Questionnaire and Functionality Mapping 47](#_Toc355723155)

[Chapter 6: System Design 48](#_Toc355723156)

[6.1 Use Cases 49](#_Toc355723157)

[6.1.1 Use Case Context Diagram 50](#_Toc355723158)

[6.1.2 Use Case Specification (Design Route Map) 51](#_Toc355723159)

[6.1.3 UC-01 Use Case Diagram (Design Route Map) 52](#_Toc355723160)

[6.1.4 AD-01 Activity Diagram 53](#_Toc355723161)

[6.1.5 SD-01 Sequence Diagram (Design Route Map 54](#_Toc355723162)

[6.1.6 UC-02 Use Case (Plan Route) 55](#_Toc355723163)

[6.1.7 UC-02 Plan Route Map Use Case Diagram 56](#_Toc355723164)

[6.1.8 AD-02 Activity Diagram (Plan Route) 57](#_Toc355723165)

[6.1.9 SD-02 Sequence Diagram (Plan Route) 58](#_Toc355723166)

[6.1.10 UC-03 Use Case Specification (XML Editor) 59](#_Toc355723167)

[6.1.11 UC-03 Use Case Diagram (XML Editor) 59](#_Toc355723168)

[6.1.12 AD-03 Activity Diagram (XML Editor) 60](#_Toc355723169)

[6.1.13 SD-03 Sequence Diagram (xml editor) 61](#_Toc355723170)

[6.1.14 UC-04 Use Case Specification (Manage Loading) 62](#_Toc355723171)

[6.1.15 UC-04 Use Case Diagram (Manage Loading) 63](#_Toc355723172)

[6.1.16 AD-04 Activity Diagram (Manage Loading) 64](#_Toc355723173)

[6.1.17 UC-05 Use Case Specification (View Loading) 65](#_Toc355723174)

[6.1.18 UC-05 Use Case Diagram (View Loading) 66](#_Toc355723175)

[6.1.19 AD-05 Activity Diagram (View Loading) 67](#_Toc355723176)

[6.1.20 SD-04 Sequence Diagram (View Loading) 68](#_Toc355723177)

[6.1.21 UC-06 Use Case Diagram (Change Language) 69](#_Toc355723178)

[6.1.22 UC-06 Use Case Diagram (Change Language) 70](#_Toc355723179)

[5.1.23 AD-06 Activity Diagram (Change Language) 70](#_Toc355723180)

[6.1.24 SD-05 Sequence Diagram (Change Language) 71](#_Toc355723181)

[6.2 Class Diagrams 72](#_Toc355723182)

[6.3 Database Design Diagram 73](#_Toc355723183)

[6.3.1 Data dictionary (TSP) 73](#_Toc355723184)

[6.3.2Data Dictionary (CLP) 73](#_Toc355723185)

[6.4 Test Design 73](#_Toc355723186)

[6.4.1 Test Plan 75](#_Toc355723187)

[Chapter 7: Implementation 76](#_Toc355723188)

[7.1 Tools used for Implementation 76](#_Toc355723189)

[7.1.1 Implementation Plan 76](#_Toc355723190)

[7.2 Implementing Complex Modules 78](#_Toc355723191)

[7.2.1 Create Random Population (TSP) 78](#_Toc355723192)

[7.2.1.1 Objective 78](#_Toc355723193)

[7.2.1.2 Description: This module basically covers the following subparts: 79](#_Toc355723194)

[7.2.1.3 Flow of the module: 79](#_Toc355723195)

[7.2.2. Crossover (TSP) 80](#_Toc355723196)

[7.2.2.1 Objective: 80](#_Toc355723197)

[7.2.2.3 Flow of the Module: 82](#_Toc355723198)

[7.2.3 Map Editor - GUI Drawing (TSP) 83](#_Toc355723199)

[7.2.4 Container loading Algorithm – Bin Packing Algorithm 85](#_Toc355723200)

[7.3 Problems (Hardest Task) 88](#_Toc355723201)

[7.3.1 Problem 1: (Mapping TSP with GA and approach of solving) 88](#_Toc355723202)

[7.3.2 Problem 2 (Generating the Graph of Loading) 93](#_Toc355723203)

[7.4 Technical Quality 98](#_Toc355723204)

[7.4.1 Memory Utilization 98](#_Toc355723205)

[7.4.2 Performance 98](#_Toc355723206)

[7.4.3 User Interface 98](#_Toc355723207)

[7.4.4 Short-Cut Keys 98](#_Toc355723208)

[7.4.5 Naming Convention 98](#_Toc355723209)

[7.4.6 Comments 99](#_Toc355723210)

[7.4.7 Validations 99](#_Toc355723211)

[7.4.8 User Manual 101](#_Toc355723212)

[7.4.9 Technical Manual 107](#_Toc355723213)

[Chapter 8 Testing 109](#_Toc355723214)

[8.1 Test Plan 109](#_Toc355723215)

[8.2 Test Duration 110](#_Toc355723216)

[8.3 Unit Testing 111](#_Toc355723217)

[8.3.1 Black Box Testing 111](#_Toc355723218)

[8.3.2 White Box Testing 120](#_Toc355723219)

[8.4 System testing 123](#_Toc355723220)

[8.4.1 Full System Testing 123](#_Toc355723221)

[8.5 Compatibility Testing 126](#_Toc355723222)

[8.6 Usability Testing 126](#_Toc355723223)

[8.7 User Acceptance Testing 130](#_Toc355723224)

[8.7 Testing Summary 131](#_Toc355723225)

[Chapter 9 Critical Evaluation 132](#_Toc355723226)

[9.1 Introduction 132](#_Toc355723227)

[9.2 Usefulness of the Beacon for Target Users 132](#_Toc355723228)

[Chapter 10 Conclusion 133](#_Toc355723229)

[10.1 Degree of Success 133](#_Toc355723230)

[10.2 Limitations and Errors 134](#_Toc355723231)

[10.3 Possible Future Enhancement 134](#_Toc355723232)

[10.4 Main Computational Challenge 134](#_Toc355723233)

[10.5 Learning Experiences 134](#_Toc355723234)

[References 135](#_Toc355723235)

[Books / Articles and White Paper References 135](#_Toc355723236)

[Website Reference 136](#_Toc355723237)

**Figure List**

[Figure 1: Travelling Salesman Problem (Weisstein, 1999) 12](file:///C:\Users\r0G3R%20b1NNy\Desktop\Final%20Year%20Project%20-%20Binit%20Kumar-x1\Documentation\Documentation.docx#_Toc355723238)

[Figure 2 : 3 Dimensional Container Loading graph (F. Parre, 1994) 12](#_Toc355723239)

[Figure 3: Analogy between a numerical GA and biological genetics (Haupt, 2004) 14](#_Toc355723240)

[Figure 4: 2D Load packer Software 29](#_Toc355723241)

[Figure 5: Market Value of Container Loading Calculator 35](#_Toc355723242)

[Figure 6 : Advanced Waterfall follows V model 41](#_Toc355723243)

[Figure 7: Bin Packing Example (Gordon, 2011) 43](#_Toc355723244)

[Figure 8 : Use Case Context Diagram 50](#_Toc355723245)

[Figure 9: UC-01 Use Case Diagram (Design Route Map) 52](#_Toc355723246)

[Figure 10: AD-01 Activity Diagram (Design Route Map 53](#_Toc355723247)

[Figure 11 : SD-01: Sequence Diagram (Design Route Map) 54](#_Toc355723248)

[Figure 12: UC-02 : Use Case Diagram (Plan Route) 56](#_Toc355723249)

[Figure 13: AD-02 Activity Diagram (Plan Route) 57](#_Toc355723250)

[Figure 14: SD-02 Sequence Diagram (Plan Route) 58](#_Toc355723251)

[Figure 15: UC-03 Use Case Diagram (XML Editor) 59](#_Toc355723252)

[Figure 16:AD-03 Activity Diagram( xml editor) 60](#_Toc355723253)

[Figure 17: SD-03 Sequence Diagram (xml editor) 61](#_Toc355723254)

[Figure 18: UC-04 Use Case Diagram (Manage Loading) 63](#_Toc355723255)

[Figure 19: AD-04: Activity Diagram (Manage Loading) 64](#_Toc355723256)

[Figure 20: UC-05 Use Case Diagram ( View Loading) 66](#_Toc355723257)

[Figure 21: AD-05 Activity Diagram (View Loading) 67](#_Toc355723258)

[Figure 22: SD-04 Sequence Diagram (View Loading) 68](#_Toc355723259)

[Figure 23: UC-06 Use Case Diagram (Change Language) 70](#_Toc355723260)

[Figure 24: AD-06 Activity Diagram (Change Language) 70](#_Toc355723261)

[Figure 25: SD-05 Sequence Diagram(Change Language) 71](#_Toc355723262)

[Figure 26: Class Diagram (Beacon) 72](#_Toc355723263)

[Figure 27: Test Plan PERT chart 75](#_Toc355723264)

[Figure 28 : Implementation Plan 77](#_Toc355723265)

[Figure 29 : General Scheme of Evolutionary Process 78](#_Toc355723266)

[Figure 30 Figure of Running Algorithm of Route Map 85](#_Toc355723267)

[Figure 31 : Distance calculation between two co-ordinates using RMS method 89](#_Toc355723268)

[Figure 32 : logic and code of Mutation in GA 92](#_Toc355723269)

[Figure 33: Initial and default parameters of TSP in GA 93](#_Toc355723270)

[Figure 34:Picture Box used as a Drawing Surface by Usercontrol 94](#_Toc355723271)

[Figure 35: Code and logic for Best-Fit Algorithm 95](#_Toc355723272)

[Figure 36 : Code Snippet from Draw Bins Sub procedure to draw graph 96](#_Toc355723273)

[Figure 37 : Change events calling compute method 97](#_Toc355723274)

[Figure 38 : Error Message because of less number of cities 99](#_Toc355723275)

[Figure 39: Showing the validations used in TSP 100](#_Toc355723276)

[Figure 40 : testConnectionValid function determines the validity of clink between cities 101](#_Toc355723277)

[Figure 41 : Type of Testing 109](#_Toc355723278)

**List of Tables**

[Table 1: Traceability Matrix between Problems and Functionalities 19](#_Toc355723279)

[Table 2: Core Functionalities Table 21](#_Toc355723280)

[Table 3: Enhanced Functionalities Table 21](#_Toc355723281)

[Table 4: Special Functionalities Table 21](#_Toc355723282)

[Table 5: 2D Load packer, Similar System 33](#_Toc355723283)

[Table 6: Opti-Map ( similar systems) 33](#_Toc355723284)

[Table 7: Language Suitability Table and comparison 38](#_Toc355723285)

[Table 8 : Packages to be used 40](#_Toc355723286)

[Table 9 : Traceability Matrix between Questionnaire, Interviews and Functionalities 47](#_Toc355723287)

[Table 10 : Traceability Matrix between Requirement Analysis and design 49](#_Toc355723288)

[Table 11 : Use Case List 51](#_Toc355723289)

[Table 12: UC-01 Use Case Specification (Design Route Map) 51](#_Toc355723290)

[Table 13: UC-02 Use Case Diagram (Plan Route) 55](#_Toc355723291)

[Table 14: UC-03: Use Case Specification (xml editor) 59](#_Toc355723292)

[Table 15: UC-04 Use Case Specification (Manage Loading) 62](#_Toc355723293)

[Table 16: UC-05 Use Case Specification (View Loading) 65](#_Toc355723294)

[Table 17: UC-06 Use Case Specification (Change Language) 69](#_Toc355723295)

[Table 18: Test Plan Sample 74](#_Toc355723296)

[Table 19 : Table of Tools Used 76](#_Toc355723297)

[Table 20 : Pseudo code of Population Class 79](#_Toc355723298)

[Table 21: Pseudo code for population and bestTour 80](#_Toc355723299)

[Table 22 : Partially Mapped Crossover Demonstration 82](#_Toc355723300)

[Table 23: Pseudo Code for Links in Link Class (TSP) 83](#_Toc355723301)

[Table 24 :Pseudo code for XML based city loading in map 84](#_Toc355723302)

[Table 25:Pseudo Code for new City generation in pictureBox 85](#_Toc355723303)

[Table 26: Packages used and pseudo code for decreasing order of bins 86](#_Toc355723304)

[Table 27: Pseudo code for Best Fit Algorithm and decreasing order of bin 88](#_Toc355723305)

[Table 28 : Pseudo code for finding the closet city 89](#_Toc355723306)

[Table 29 : Fitness Calculation code for each tour 90](#_Toc355723307)

[Table 30: List of methods used in drawing the loading graph 97](#_Toc355723308)

[Table 31 : Use of List and Inheritance for memory utilization 98](#_Toc355723309)

[Table 32: Showing naming convention used in code 98](#_Toc355723310)

[Table 33:Showing the used of xml comments to describe code 99](#_Toc355723311)

[Table 34 : User Manual Table 106](#_Toc355723312)

[Table 35: Technical Manual Table 108](#_Toc355723313)

[Table 36: Type of testing involved 110](#_Toc355723314)

[Table 37 : Test Duration Table 110](#_Toc355723315)

**List of Equations**

[Equation 1 Equation to create random population 79](#_Toc355723316)

[Equation 2 : Fitness Equation 90](#_Toc355723317)

# Chapter 1 Introduction

T

he past two decades is the era of the personal computers and information technology . The mathematical algorithm is no longer just participating with our world – they shape it. Algorithms are used in calculation, data processing and automated reasoning. From Financial market to small mobile device, everything uses a smart algorithm to reduce the complexity of some problem and make the technology looks wonderful. But there are questions that remain unanswered? How the Information Technology Field will change in the next 10 years. If we will find some algorithmic approach to solve a problem that is best suited and most optimized.

## Topic of the System

The Primary goal of the project “Beacon (Hi-Tech Marine Loading and Path Detection System)” is to resolve the logical and mathematical complexities in the Logistics System. The project provides a new approach of solution to two popularly known NP-hard problems, Travelling Salesman Problem (TSP), Container Loading Problem (CLP). Beacon keeps everything organised, updated, smart and accessible.

## Purpose of the Situation

The Developer is sensing immense scope and intelligent system name Beacon that uses advanced genetic and greedy approach of solving the problem, a new algorithm is generated to solve the complex and unsolvable problem. The approach results a optimize solution of the scenario.

Every Logistics company that transfer heavy goods materials to different destinations plans the routing of the vehicle (Trucks/Ships) to manage the cost of travel. This cost is very critical to the business process and can save lots of money. Route Planner is basically required here to get the optimized and shortest route. Since the number of stops are uncertain and a very large number of stoppage can cause a very problematic situation to find the best possible solution. This problem is commonly known as Travelling Salesman Problem in Algorithms.

|  |
| --- |
| http://mathworld.wolfram.com/images/eps-gif/TravelingSalesmanProblem_1000.gif  Figure : Travelling Salesman Problem (Weisstein, 1999) |

The second algorithm developer is doing is related to marine loading. Large numbers of container are being loaded to ships and other vehicle for supply. It is always a tedious task for loading staff to manage the containers and make a optimize load plan. The load plan should be made so that the maximum number of container gets load without affecting the balance of the ship. The problem arises due to different number of containers get transported with various size of goods materials.

|  |  |
| --- | --- |
| Figure : 3 Dimensional Container Loading graph (F. Parre, 1994) | Different Boxes are arranged in order so that there must be maximum number of the box in the ship. |

## Target User of the System

Target users are group of those people for whom the system is going to be developed for.

* **Shipping Companies/SMEs /Courier Company** - Organization who manages a large supply or export/import packages to move on.
* **Skilled People targeted** – Package planner, Package Loader, Insurance People, Manager, Accounts. The system also targets different worker of same enterprise according to work divided.
* **General/Typical Users -**Any person who wants to control their data can use the system.
* **Research peoples and Students** – The advance algorithm and problem solving techniques can be used in academics and research.

## Topic Background

The basic idea of the system is to solve the complexity in the enterprises in route mapping and container loading. Both the Idea is unsolvable due because of being a NP hard problem that cannot be solvable and verifiable in polynomial time. To solve this algorithm in the feasible time, a backtracking approach needs to be applied. Genetic algorithm is one of the various effective ways to approach for solutions of NP-hard and NP-complete problems.

**Bin Packing Algorithm** is a mathematical way to deal with efficiently fitting Elements into Bins. The hitch is that Bin packing problem is classified as the NP-complete problem. Basically means that there’s no way of being guaranteed the best solution without checking every possible solution. The goal of every Bin Packing algorithm is to use the least amount of Bins to hold the required number of Elements. (Dirk, 2009)

**Genetic Algorithm** is a search heuristic algorithm that is routinely used to generate useful solutions to optimizations and search problems. It generated solutions to optimization problems using techniques inspired by natural evolution, such as inheritance, mutation, selection and crossover. Genetic algorithms are one of the best ways to solve a problem for which little is known. (Bajpai, 2008)

|  |
| --- |
| Figure : Analogy between a numerical GA and biological genetics (Haupt, 2004) |

## Problem Context

In the present world, Information System and calculations plays a very vital role in every place. Every real world problem can be linked as an entity and the corresponding relationships can be defined in between.

Beacon is responsible to solve the complexity of the problems and system of any logistics company. Its solves the mind jolting and tedious tasks automatically using its advanced algorithms and data flow design .Complex problems like TSP (travelling salesman problem ) CLP (container loading problem ) can’t be solved manually or any other way .Beacon keeps everything organised ,updated ,smart and accessible.

## Description of the Problem Area

* To enter data of the goods to be transported and organizing the relationships between data is a complex and time-taking tasks. Every goods from nail to big industry parts are needed to be logged into the system with its specifications and related data .What are the materials going to transfer in which container and vehicle.
* The information related to the goods, transported like basic price of goods, charge of transportation, value, size, weight, owner, destination, insurance papers etc. This data are needed to be arranged in the normalized manner to solve the data redundancy and availability.
* Efficient algorithm for solving the TSP with the facility to import map coordinate or create a weighted graph. To solve the problem with the advanced genetic algorithm is also a tedious and brainy task that includes various constraints like time, amount of goods, traffic etc.
* Second most important algorithm need to generate to solve CLP of ships. To generate whole new algorithms is the research part in the project .Also the system is responsible to generate 2D/3D graphs to show the efficient container loading .This features include a high level of challenge and skills.
* Implementing the unique ID generation for the transport and the goods is also a challenge, these Ids can be used to track and update the status. Also small mobile app can also be used for the customer of the company to manage their goods.
* Features like language support and import of data through excel sheets, interactive reports are also the problem areas which are not clear.
* **Setting an example** – Mr Sharma is a famous business man from India. His company exports various things like natural resource (coal, iron ores, etc.), agriculture product, couriers, vehicles and everything from ships and trucks. He needs to cut the expenses from the TSP and CLP problem in the system .Company can saves thousands of dollars if they have efficient algorithms for the best loading and supplying .And also they need the interactive system to deal with the various constraints, data and reports of every transportations.

## Rationale behind the System

As obvious from the problem context presented above the situation warrants such a system that helps reducing the complexity , solve the TSP , CLP problem that is impossible to solve in any manual way or by supercomputers . In TSP and CLP the problem grows exponentially fast in every turn that makes its unsolvable when the inputs of data is in more in numbers. When the destination in TSP is more than 20 or in CLP .It’s very tough to create the optimal solution of the problem using any straight approach.

**Setting an example**: A company like DHL is known for exports/imports business and they need the system to plan, organize and track the goods. Beacon is perfect in this situation .It’s also has small mobile app for users to track the products.

**Benefits of the System**

The system implemented could bring about significant tangible and intangible benefits. Given below is a list of tangible and intangible benefits expected from the system:

**Tangible Benefits**

* **Reduced Complexity of Problem**- This system generates the optimal solution that seems impossible to solve manually or technically .TSP and CLP problems are being solved with the most efficient problem solution being designed and implemented by developer.
* **Graphical view of route and container loading** – The system will generate 2D/3D view of the containers to show the best loading graph in CLP and the best route graph in TSP. Its gets easier to load container using graph and route map makes the route clear.
* **Organized Data and accessibility** – The Data of every container is very much organized and validated during entry and can be used to plan a consignment. Also every goods/material will gets easily to track as per the unique id provided .The status can be made available for the customer in the current time.
* **Cost Benefits** - Cost being “the most” important factor for any organization, it’s always beneficial to adopt cost-cutting or cost-saving measures. With Beacon, cost benefits come in following ways-

Most efficient route will be produced, results in precious fuel saving hence cost cutting. Best Container loading plan optimizes the overall loading with the ships and also maxims the number of container .Hence this reduces the administration and managerial overhead results into cost benefits

* **Time Benefits-** with Beacon, the time of container loading reduced efficiently as everything will be decided by the system will be pre-planned. Report generation and task assignments are easier to discuss and also proper planning and scheduling make the most out of work in minimum time. Trucks and ships save time by going through the shortest path provided results in more resource availability. **For Example:** More the trucks reduce the time of travelling; more the loading of trucks will be possible. Also the container loading takes the minimum time in ships.

**Intangible Benefits**

Increased Employee /Enterprise productivity – With employee being aware about the task and work division among the organization, it results into employee task productivity. For Example – The Work load is very much reduced by the algorithms of TSP /CLP and also the planning tool makes the productivity easier .The Consignment planner can easily arrange every box and goods.

* **Increased work flexibility and easier to understand and operate** – The work load assigned are easier to plan and manage and keep track of the work progress .Also the Beacon makes it easier to understand the problem statement and to organize and plan the things based on different constraints. **For example** - Desirable production and better planning can be targeted as the vision of the project.
* **Increased customer satisfaction** - All organizations churn out some services whose final consumer is the customer .With Beacon promising to deliver so much for improving the productivity and uptimes for the businesses they are surely going deliver better results for their end customers thereby promoting customer satisfaction and customer loyalty thereby increasing business for the organizations.
* **Reduces stress**- – The automated advanced application that works on backtracking can automatically reduce the stress and work overhead of the users.

## Project Objectives

* To learn advanced programming techniques, software engineering principles, project management concepts, advanced algorithms and integration of varied technologies.
* Learn about domain area, i.e. Genetic algorithms and Greedy Approach of solving graphs in algorithms
* To implement the knowledge gained in Objective 1 to develop such a system which leads to goal mentioned above.
* To make efforts to ensure that the system being developed will fulfil all the tangible and intangible benefits mentioned in the previous section.

The Proposed system intends to allow engineers to manage their container loading provided with the unique id of every container. The system manages all the data using an integral optimum methods to organise them as the weight remain same and the overall container loading doesn’t affect the balance of the ship or anything .In second stage it provides the route map of the ship. All the input data are verified and validated with unique ID. Custom report generation, language support, data entry through excel/xml files and other are some other enhanced features. The important feature of the system is the graph generation of the container loading in 2D/3D.

The modules for the proposed system have been listed below:

***Software Module:*** This module will be installed on desktop machine of the organization .Different software are divided mainly for data entry, container loading and route map and report generators.

***Database Module:***  This module will save every single consignment for the company with details of final results of TSP and CLP.

## Academic Objectives

* To learn advanced algorithmic approach like greedy algorithms, genetic algorithms and implementation of algorithms.
* To create a research paper and whole new approach to solve the travelling salesman problem and container loading problem.
* Project management concepts like methodologies, scheduling, time estimation, work breakdown techniques and tools etc.
* Implementation of the algorithms derived into visual basic to create a running application while learning the programming background of the technology.
* To make efforts to ensure that the system being developed will fulfils all the tangible and intangible benefits mentioned in the previous section.

## Traceability Matrix between problems and functionalities

|  |  |
| --- | --- |
| **Problems** | **Solution** |
| Map Design | Editor to draw a weighted graph of route |
| Best Route | Best optimized route generator using Genetic Algorithm |
| Container Information | Data entry and Validate of each container |
| Optimized Load Plan | Best solution using Bin Packing Algorithm |
| View Load | 2D /3D view of the final loading |
| Different Language | Language Support |
| Easy data entry | Using Excel sheets/Export –Import / XML |
| Document Generation | Printable document generation as a report |

Table : Traceability Matrix between Problems and Functionalities

## Assumptions

The successful implementation of the project is much depends on the understanding of the user towards the system. So as this system is developed for a logistics company so it is believed that all the users are expert user and know about it. Since developer is providing a solution based on his own research, so there may be other best possible way to solve the problem. One or more than one user may be responsible to use the system, developer is using work break structure of company. Predefined boxes and map are included in the system to show the usability, however one can change specification according to their needs. Language support is very vast. The system can be installed and ready to be used and developed to work on windows environment. The final output/result of route/load plan can be saved in image or pdf file and can be copied or used elsewhere.

## Success Criteria

Success Criteria depends upon the depth of understanding and experience gained from this project and how efficiently developer solves the problem described above.

## Project Scope

The proposed solution is desktop-based standalone application for solving to algorithmically complex task. The system can be downloaded or used by directly installing into the windows machine. The final output or result produced by using the application can be used as image or word files and can be used later

The features of the application are –

* **Editor for graph Design**: This will be the simple editor to design a weighted graph on the system .It includes toolbox and other specification of node and path in the graph.
* **Route Optimizer Module**: This is particularly the research part in the system .It create the major algorithmic approach that will take data from the editor or predefined map and solve the problem to create the best optimized path.
* **Data entry and Validate Module**: This module can be used to create new specification of boxes (weight, size etc) and the good contained in every box. All the entry must be verifiable cannot exceed the specification.
* **Loading Planner Module**: This module is the main feature and research part in the system that used advanced algorithmic approach to solve the loading plane based on the data entry and validate module. This will result a best optimized load plan for the ship or trucks.
* **Graph generator Module**: The final 2D /3D graph of loading is generated in this module using the load planner module.
* **Language Support Module**: More than 3 languages support are provided in the system. All the name, word will be changes by selecting one option.

## Limiting the Project Scope

* The application is strictly desktop based standalone application include no support from the external source or web. Although the result of route and load can be used as image or word file.
* There is no support for third party application or Google map.
* There is no major database role in the system, it can use some simple excel file or MS Access records.

## Functionalities of the System

**CORE FUNCTIONALITIES**

|  |  |  |
| --- | --- | --- |
| # | Functionality | Description |
| 1. | Data entry and Unique ID | The information about each Routes and container need to be logged in the system with unique identification. |
| 2. | New Algorithms for TSP  ( Research Paper ) | Intelligent Genetic Algorithm to determine the shortest and the best path for transportation. Mapping real world Natural Selection process into programming to solve TSP  (**Refer to Appendices for Research Paper** ) |
| 3. | Implementation of TSP | Implementation of TSP problem on graphs taking co-ordinates from a real world scenario |
| 4. | Algorithms Design for CLP | Bin Packing Algorithm that solves CLP that provides the optimal container loading solution and ship balance. |
| 5. | Implementation of CLP | Implementation of Container loading for a ship with various box of different size |

Table : Core Functionalities Table

**ENHANCED FUNCTIONALITIES**

|  |  |  |
| --- | --- | --- |
| # | Functionality | Description |
| 1. | Language Support | Different Major Language Support for the system. |
| 2. | XML Data Reader and Writer | Data entry through xml files |
| 3. | Interactive Report and Document Generation | Automatic and downloadable Insurance , Bill , Transport Agenda and other report generation |

Table : Enhanced Functionalities Table

**SPECIAL FUNCTIONALITIES**

|  |  |  |
| --- | --- | --- |
| # | Functionality | Description |
| 1. | 2D /3D view of CLP | Loading Plan of containers |
| 2. | Map Editor for TSP | Map Editor for TSP |

Table : Special Functionalities Table

## Feasibility Analysis

Feasibility studies addresses things like where and how the business will operate. It provides in-depth details about the business to determine if and how it can succeed and serve as a valuable tool for developing a winning business plan.

**Schedule Feasibility Report**

It consist of assess the work to which the time frame and the completion date for all major activities within the project that meets organizational deadlines and constraints for affecting change.

The main part of schedule feasibility report is-

**Gantt chart** - Developer has used this chart for the time estimation.

**Technical Feasibility**

Technical Feasibility mainly involves the hardware and the software requirements of the system regarding all the tasks of the system to be done

**Minimum Hardware Requirement**

* CPU: 2.0 GHz Pentium IV or above,
* Memory: RAM 512 MB
* Disk Space: 5 GB space (at least)
* Monitor: Any Standard Monitor
* Peripherals: Mouse, Keyboard

**Software Requirement**

* Operating System: Windows® 7, Windows XP,
* Software Development Tools: Microsoft Visual Studio 2010,
* Project Management Tools: Microsoft Project, Visio 2010,
* Case Tools: Smart Draw, Visual Paradigm 6.0,
* Graphic Design Tools: Adobe Photoshop CS4,
* Database : Microsoft SQL Server 2008,
* Documentation: Microsoft Office 2010.

**Operational Feasibility**

It may be defined as, the process of assessing the degree to which a proposed system solves business problems or takes advantage of business opportunities. Problems addressed and advantages of this system are provided in the documentation.

**Economic Feasibility**

The purpose for assessing economic feasibility is mainly to identify the financial benefits and costs associated with the development project. Economic feasibility is referred as cost and benefit analysis for any system.

Once the technical feasibility is established, it is important to consider the monetary factors also. Since it might happen that developing a particular system may be technically possible but it may require huge investments and benefits may be less. Cost Benefits are included under Rationale by the developer.

## Project Planning

**Project Management**

*“ Process of planning, directing and controlling the development of an acceptable system at a minimum cost within a specified time frame.”* (Whitten et al, 1994)

**Time Management**

Project started on date and will be completed on the date specified in the academic requirement. Start and End Date is already specified in the Project Development Plan. After estimating the time, activities were sequenced to create the Gantt chart. Activities can be adjusted to meet the academic dead line through change control process. (For Gantt chart see Appendix Section)

**Deployment Plan**

V-Mode has five stages these are: are Concept and operation, Requirement and Architecture, Detail Design, Implementation, Elaboration Phase, Construction Phase and Transition Phase. Below it describes, how there phases are involving in my project. (Time Division for Deployment Plan is fully explained in 4.2.3.3 Section).

## Ethical Issue

It ensures that the project won’t do any harm to the society or anyone in anyways. It contains issues like no animal harm & no copying of data without prior permission etc and to ensure that the developer has filled up an ethical form and it will be provided in documentation.

# Chapter 2 Problem Description

## 2.1 Introduction to Problem Area

In this era of Information Technology and Computation ,every little work is expected to done smartly and speedily .Sorting is by no means the only computational problem for which algorithms have been developed .Practical Applications of algorithms are ubiquitous and include various problems like Travelling Salesman Problem and Container Loading Problem.

## 2.2 Problems Identified

Beacon is going to solve many real time problems that companies face on daily basis as –

* **Easy Data Entry** – Co-ordinate of map need to be easily entered. Specifications of Containers are different and must be defined by shape and weight.
* **Route Map Plan** - Best optimized path of travelling with downloadable plan. Easy solvable for large number of problems.
* **Load Plan** – 2D /3D view of optimized container loading for a single consignment.
* **Path Editor** – Easy Path Editor so that destination can be altered accordingly
* **Language Support** – Different Language Support
* **Consignment Planner** – Easy Planner for each consignment and goods on go.

## 2.3 Problem Importance and Justification

* **Easy Data Entry** – Since the number nodes entered in route planner is huge, it should be easy and portable. Same in Load planner, there are various boxes of different sizes and shapes. Excel file based entry makes data easier to input. Also the graphical user interface are need to be with the design principle of human interaction .The information entered must be validated and crosschecked before getting a final output.
* **Route Map Plan** - Best optimized path of travelling with downloadable plan. There’s no solution that is verifiable within the polynomial time to solve this problem because it grows exponentially at every step. In any Logistics company, the problem is same as Travelling Salesman Problem. The possible paths can be predetermined and can be solved to get the best way when the number of destination is high.
* **Load Plan** – 2D /3D view of optimized container loading for an every consignment need to generate. This is the main feature plus the most tough and complex problem of the project. It is very hard to map a large number of uneven containers into an algorithm to get a 3D model of optimized load. Also the loading include longitudinal balance of the vehicle /ship and the mass must be distributed evenly.
* **Path Editor** – Editor is the graphical feature and challenging to develop. The entire route can be defined manually in the editor by drawing a weighted graph. It includes direction and weight in the graphs same the distance and direction of the road map.
* **Language Support** – More than 1 language support are provided to the software, so that it can be used by different users who differs in their demographic background.

## 2.4 Challenges in the Project

The development of Beacon calls for numerous challenges to be faced by the developer which includes learning curve of new concepts, learning new development tools, mastering already known tools, domain analysis, new programming languages etc.

**Challenges**

The development of Beacon (Hi –tech Marine Loading and Path Detection), calls for numerous challenges to be faced by the developer which includes learning curve of new concepts, learning new development tools, mastering already known tools, domain analysis and new programming languages etc.

## 2.5 New Concepts, Theories and Technologies to be learnt

**Concepts**: Various new concepts includes in the project mainly in the research part. Genetic algorithms, Greedy Approach, Heuristic approach of algorithms are the new concepts in the algorithm. Concepts include generation of algorithm, mapping it into programming and generation the right user interface. It includes matching of real word problem as an entity to the scientific approach of problem solving followed by defining the relationship between them to get a best optimized solution.

**Theories:** The theory is very complex to map with the algorithms and solvable approach. To map the real world problem into the binary or any data structure and generating a backtracking approach is real tough task. All the best solution comes after mutation and theory of natural selection in the genetic approach.

Next challenge is to map this solution of the real world problem into the programming language. It includes various graphs theory and complexity of the programming modules. The parameters of data entry and entity are identified by the data gathering and research theories.

**Technologies**

**Programming Language Skill**

**Visual Basic** – The application running on the windows machine is going to be developing using visual basic. Mastering Visual Basic is a significant challenge given the steep learning curve it requires with pre-requisites involving skills of working with graphs, procedures, class, libraries and implementing algorithmic approach in it. **(Refer to 4.2.1 for Programming Language Research)**

**Graph Technology** - The identification, generation and working on a graph is the tough task especially when it is random and created by some logics. The graph of TSP is created using edit and the final output of the CLP is some 2D or 3D graph .This part is very hard and need constants learning curve.

# Chapter 3 Literature Review

## 3 Literature Review

A literature review is a description of the literature relevant to a particular field or topic. It gives an overview of what has been said, who the key writers are, what are the prevailing theories and hypotheses, what questions are being asked and what methods and methodologies are appropriate and useful. As such, it is not in itself primary research, but rather it reports on other findings. This contains following things-

## 3.1 Advanced Preliminary

The Idea of this project came into developer mind while he was learning the applications of algorithms and capability of doing smart stuffs. The idea has been derived in the process of learning a blog on genetic algorithm and its application. Developer thought of this idea could be implemented for big and small logistics company that can be a highly cost and time beneficial .Also developer was quite interested in learning the advanced and scientific approach of algorithms that he knows a little bit from course module.

The developer performed an extensive research of the topic & found IEEE research papers that guided the developer towards the logic and approach on algorithms design and implementation

The **excerpts from these research papers** are given below-

**“The Single Container Loading Problem (CLP) is a three-dimensional packing problem in which a large parallelepiped has to be filled with smaller parallelepipeds, available in different sizes and limited quantities, so that empty space is minimized**

**When speaking about real-world container loading problems space usage is the most important objective, but other issues have to be taken into account, such as cargo stability, multi-drop loads or weight distribution. Among these additional considerations, cargo stability is the most important one.**

**In this paper we present a new algorithm for the container loading problem that is based on an original heuristic enhanced by a GRASP solution space search strategy. “** (F Pareno and R. Alvarez ,2009, pp.1-3)

**“For solving TSP, numeric, heuristics, genetic, hybrid or other algorithms may be used, as this problem is not easy to solve for large number of cities, the computation is often deployed on multi-processor or clustered hardware**

**The problem has to be coded into data structure, which can be handed like a chromosome.**

**For TSP, the chromosome is set of ordered indexes of cities, through which the traveller goes. For other problems, it could be integer or real number, for difficult tasks, there is idea of using Neural Networks for coding the problem”** (Dusan Saiko ,2005 pp. 1-4)

The Developer knew few things before developing the project:

1. **2D load Packer**- It is popular application that is used for creating load plan. It uses some algorithmic approach to solve the problem of loading while taking care of the longitudinal balance of the vehicle in terms of weight. Tasks, Containers and Boxes are entered, edited and manipulated. It generated a load plan in 2D after getting all the validated input from the user.

|  |
| --- |
| http://www.astrokettle.com/2dlp1.gif  Figure : 2D Load packer Software  **Source : http://www.astrokettle.com/pr2dlp.html** |

## 3.3 Depth of Secondary Research

The developer conducted secondary research from various Books, Websites and Magazines etc. to find out about the development process of proposed system and for this the developer needed to find about following areas-

**Domain Research**

**Topic Background**

Algorithms are the key change process in any problem in the market that results into various benefits in today scenario of computation. Particularly genetic approach of solving problem with natural selection is applicable in most of the NP problem and treated as the best approach of solving discovered in most of the cases. Marine Loading and Path Detection is such a system. Kevin Slavin believes the power of algorithms in shaping our world in TED Global Conference 2011

**“All the fun is powered by algorithm, we may not realise it but we live in the algorithm world “** (Slavin:, 2011)

**Conclusion Drawn**: Advanced algorithms are a smart changing key to change the way anything computes. It makes the things readable and processed smartly at the same time , that is not possible in any other way .They acquire the sensibility of truth because they repeat over and over again. And they ossify and calcify and they become real.

**Travelling Salesman Problem**

**"If there are n cities a salesman must visit, and the distance between each pair of these cities is given, find the shortest tour where each city is visited exactly once and returning to your starting point."** (Anonymous, 2000)

Euler introduced a form of the travelling salesperson problem in 1759, and it was formally named and introduced by the Rand corporation in 1948 (Michalewicz, 1992)

This problem in the route planning of Logistics Company is exactly same as in TSP. To find the best route between different destinations could be best found using genetic algorithm.

**Container Loading Problem:** a genetic algorithm (GA) for the container-loading problem. The main ideas of the approach are first to generate a set of disjunctive box towers and second to arrange the box towers on the floor of the container according to a given optimization criterion. The loading problem may include different practical constraints. The performance of the GA is demonstrated by a numerical test comparing the GA and several other procedures for the container-loading problem. (Gehring, Borltfeldt 2008, pp 1)

**Design Principle**: The design principles that need to be studied in order to provide are as follow:

* **Visibility:** Visibility is one of the most important design principles and what it means is that, as and when the user looks on the system screen he/she may feel the possibility for action. The developer will keep an eye on this principal in order to provide better visibility.

**Conclusion**: The developer will provide colour schemes in a way that users of this system can easily find suitable content.

* **Feedback**: Feedback is the response to the user of the action performed.

**Conclusion**: The developer will provide appropriate message box and notification to provide feedback.

* **Constraints:** Constraints are some universally accepted conventions which notify some specific actions.

**Conclusion:** Inclusion of warning messages to show the errors.

* **Consistency**: Consistency means maintaining similar colour schemes, backgrounds, font colour and size etc.

**Conclusion**: The developer will provide Consistent Colour, Same background, same font size and colour for the whole application

* **Affordances**: Affordance means expected behaviour like cursor of mouse changes into hand symbol on roll-over the link.

**Conclusion**: The developer will provide features like double clicking etc on editor.

**3.4 Programming Language Research**

**Visual Basic**

* Provides very easy GUI creation using its tools, picture box and user control features.
* Provides built in support for data grid view and other custom reporting.
* Easy event handlers, procedures can be designed
* Partial classes and static method can be easy implemented
* Generic library class and Array list can be easily inherited within classes.

## 3.5 Research on Similar Systems

|  |  |
| --- | --- |
| **Contents** | **Description** |
| **Product Name** | **2D Load Packer** |
| **Description** | 2D Load Packer (2DLP) is the unique space optimizer designed to help you plan quickly and easily the best compact arrangement of a number of different size 2D rectangular objects ("Boxes") within one or more 2D rectangular Container. 2DLP is based on the truly two-dimensional original packing algorithm. |
| **Functionality** | * The overall load weight limit and truck axle weight limits can be taken into account as the additional constraints or actual optimization factors. * The program has a facility for specifying the associated cost for each box (part) / container (sheet) item in order to calculate totals and affect the optimization as an additional priority factor. Optimizer goal and other main settings are adjustable. * The program can optimize over multiple containers (sheets) in multiple sizes at the same time, taking into account overall item set considered, as well as allowed item orientations specified for each item separately or for all together * The Image Page presents 2D views of the container (sheet) layouts and Area / Weight utilization diagrams. Layout patterns are displayed graphically as the complete adjustable full-colour images. You can observe step-by-step load sequence and print any image view, as well as other task and solution data reports. * The system supports network data sharing and has some specific DB export / import facilities, allowing a user to exchange selected task / solution data with another 2DLP system. |
| **Limitations**  **(if any )** | The program takes generates only 2D image of the final loading as it takes only one surface to load on.  Suited for container of same height only. |
| **User Review** | User rated it with 3 stars, but algorithms, speed and designs are really appreciable. |
| **Link -** | http://www.astrokettle.com/pr2dlp.html |

Table : 2D Load packer, Similar System

**Conclusion:**

* Container includes the size and amount of goods inside it to the file.
* 2D application can be generated if the height are the same but it is a limitation
* Sample Container can be defined and used further.

|  |  |
| --- | --- |
| **Contents** | **Description** |
| **Product Name** | **OptiMap - Fastest Roundtrip Solver** |
| **Description** | OptiMap is an online application that solves travelling salesman problem and any other cyclic route problem and provides shortest distance route. It is developed using Google API and use latitude/longitude as co-ordinates to solve. |
| **Functionality** | * Can substitute address for a city making it an intra-urban travelling problem * Can enter the nodes by clicking in Google map interface * Can also enter address manually by using text fields * Can also add text list, all the address at one time * Toogle raw path gives you exact latitude/longitude co-ordinates in the sequence for this route |
| **Limitations** | Can solve upto 100 nodes only |
| **User Review** | Give 3 out of 10 |
| **Link -** | http://gebweb.net/optimap/ |

Table : Opti-Map ( similar systems)

**Conclusion:**

* To deal with high number of container it requires connecting with some database.
* Weight distribution can be analysed along the longitudinal axis.
* Loading rules can be imposed using panel permit or something.

## 3.5 Quantitative and Qualitative Matrix

|  |  |  |  |
| --- | --- | --- | --- |
| Features | Beacon | 2D Load Packer | OptiMap |
| Map Editor | ✓ |  | ✓ |
| TSP(>20 )Cities | ✓ |  |  |
| Route Graph | ✓ |  | ✓ |
| Database Support | ✓ | ✓ |  |
| XML Reader | ✓ |  |  |
| XML Writer | ✓ |  |  |
| Container Planner | ✓ | ✓ |  |
| Choice of algorithm | ✓ |  |  |
| Loading Graph | ✓ | ✓ |  |
| Loading Sequence |  | ✓ |  |
| Box Size Editor |  | ✓ |  |
| Language Support | ✓ | ✓ | ✓ |

## 3.6 Market Value of the Project

There is no product in the market that solves both route complexity problems with travelling salesman problem. The approach of and the solution is still not identifiable as the best possible. Genetic approach is hard to apply but it gives a near to optimized output for larger number of products

Effland from Denmark has rated CLP as five stars in terms of complexity with average budget of $500 at website (freelance.in).

|  |
| --- |
| 17 Bids  $750  **Freelancer.in, A leading freelancing website**    Only half of the functionality of this Final year project |

Figure : Market Value of Container Loading Calculator

# Chapter 4 Research Methods

## 4.1 Primary Research

The chapter focused on primary of the project. Developer has done this in the initial stage primarily for gathering the information from the potential user of the system. The information is critically analysed and documented so that at the end it is user acceptable. Primary researches are done through following techniques.

### 4.1.1 Questionnaires

Questionnaire (**Refer to appendices for questionnaires**) is a part of data gathering technique in which a series of questions designed to gather specific information. Questionnaires will specially be designed for users who would use the system which will include people who are either staff of the logistics company or on crew of ship. They have few advantages as Questionnaire –

* Can be used to collect both qualitative and quantitative data
* Can be distributed manually or electronically
* Can reach a vast number of people regardless of physical location or geographical dispersion
* Can be distributed quickly and cheaply
* Can be used when human and financial resources are not available to conduct interviews

**Why Questionnaire?**

As this application is basically targeting to a specific group of professional who are going to use the proposed system, so they are huge and difficult to contact, so it is not possible to take interview of them because it will be huge time consuming. There are some reasons for using Questionnaires-

* The analysis of questionnaire is most efficient than other techniques as we can draw the graphs and analyse the data.
* It can reach a vast number of people regardless of physical location or geographical dispersion.
* It can be distributed quickly and cheaply.

### 4.1.2 Interviews

Interview (**Refer to appendices for Interview)** is a part of data gathering technique in which a series of question asked face to face from users of the system, designed to gather detailed information. They have few advantages as Interview –

* Can be used for evaluating information needs as interview will allow us to gather detailed information about functionalities of project
* Can be used for gathering knowledge about perceptions of the staff about the application.

**Why Interview?**

* It provides us with immediate an response which saves the developer’s precious time
* It allows participants to express themselves in their own words
* It allows the collection of a large volume of rich data
* It allows discussion, probing and unexpected insights
* It is best for investigating problems

## 4.2 Secondary Research

Secondary research means finding information from third-party sources such as marketing research, websites, magazine articles, and other sources that is already published or gathered by somebody. Books, journal articles and research paper those are necessary in order to understand the project.

### 4.2.1 Technical Research

This part is going to research the proposed system technically means what programming language the system is going to use. As the proposed system is an algorithmic application, so only few languages to choose from and these are C++, C#, Visual Basic and Java. To choose the best suitable development language for the proposed system, developer carried out a lot of research on different languages.

### 4.2.1.1 Programming Language Research

This part is going to research the proposed system about the programming language, the system is going to use.The selection of right platform for development of project is prior requirement of developer. While selecting the programming language the developer takes care of following issues:

* Modules to be developed
* Time of development
* Interface required
* Application programming

Developer had decided to go for Object Oriented Language which supports GUI interface, and can reduce developer’s time in designing the interface itself. The best options available with him are:

### 4.2.1.1.1 Visual Basic, Java and C++ comparison based on project

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Comparison** | **Visual Basic** | **Java** | **C++** | **Python** |
| **Learnable** | Very Easy | Hard to Easy | Easy to Hard | Easy |
| **Graphic generation and Support** | Best suited for Graphics , Reporting Applications | Can be used using Libraries, Need extra effort to learn | Very Hard to implement in C++ | Tedious task |
| **OOP feature and Exception handling** | Fulfills totally | Fulfill | Fulfill | Fulfills |
| **Error Elimination** | Easy | Hard | Hard | Hard |
| **File Stream and Database** | Easily compatible with Excel and Java | Hard | Very Hard | Very Hard |

Table : Language Suitability Table and comparison

### 4.2.1.1.2 Reasons for choosing Visual Basic .NET for Beacon

* **RAD**: Rapid application development tool, reduce time and efforts in application development. Within a matter of minutes a complete **Graphical User Interface (GUI)** can be produced; thus requiring less programming time and less design time for Beacon
* **Multithreading:** Visual Basic .NET applications can perform multiple tasks simultaneously using multithreading (or free threading), a process in which individual tasks execute on separate threads. Multithreading improves the performance and responsiveness for Beacon. Threading concepts are used when **executing various events** at same time
* **Globalization:** Using dozens of different objects in the **System.Globalization** namespace, developer can customized language difference such as fonts and right to left writing styles, calendars and different patterns for dates, currency , numbers etc. VB.NET is fully Unicode compliant and the advantage is that developer can display virtually all characters in all languages. **Language Change feature** use this concept in Beacon
* **User Control:** provide a means by which custom graphical interfaces can be created and reused. A user control is essentially a component with a visual representation. It can consists of one or more Windows Forms controls, components, or blocks of code that can extend functionality by validating user input, modifying display properties. It can be simply used in the same manner as other controls. **Bin Packing Graph** will be created using this concept
* **Project Wizard** : can be used as a powerful tool which can generates the code automatically, help a lot as less prone to typing error. Using wizard user do not help to enter code line manual but just have to configure the things within the project.
* **OOP Concepts**: Supports object oriented concepts and a class can inherit other class as a base class and can also define its own properties in derived class. **City, Cities ,Tour , Population class** uses inheritance and other oops features in Beacon
* Classes created in VB.NET have public access modifier by default and can be inherited by any other class within the same project.

## 4.2.1.1.3 Packages to be used

|  |  |
| --- | --- |
| **Packages** | **Justification** |
| Imports System.Globalization | For Culture Related information includes language, country, region, calendars etc. |
| Imports System.Drawing.Drawing2D | The System.Drawing.Drawing2D namespace provides advanced two-dimensional and vector graphics functionality. |
| Imports System.Collections.Generic | contains interfaces and classes that define generic collections, which allow users to create strongly typed collections that provide better type safety and performance than non-generic strongly typed collections. |
| Imports System.Text | contains classes that represent ASCII and Unicode character encodings; abstract base classes for converting blocks of characters to and from blocks of bytes; and a helper class that manipulates and formats String objects without creating intermediate instances of String. |
| Imports System.ComponentModel | provides classes that are used to implement the run-time and design-time behaviour of components and controls. |
| Imports System.Data | provides access to classes that represent the ADO.NET architecture. ADO.NET lets you build components that efficiently manage data from multiple data sources. |
| Imports System.Threading | provides classes and interfaces that enable multithreaded programming |
| Imports System.IO | contains types that allow reading and writing to files and data streams, and types that provide basic file and directory support. |
| Imports WindowsApplication1.Beacon | Use classes within the Beacon itself e.g. BinPackingGraph , Usercontrols |
| Imports System.Windows.Forms | contains classes for creating Windows-based applications that take full advantage of the rich user interface features available in the Microsoft Windows operating system. |
| Imports System.Data.SqlClient | The System.Data.SqlClient namespace is the.NET Framework Data Provider for SQL Server. |

Table : Packages to be used

## 4.2.2 Methodology: Advanced Waterfall

## 4.2.21 Description

The Advanced waterfall provides an orderly sequence of development steps and helps ensure the adequacy of documentation and design reviews to ensure the quality, reliability, and maintainability of the developed software.

Requirements Analysis

Usability Testing Design

System Design

System Testing

Architectural Design

n

Integration Testing

Module Design

Unit Testing

Implementation

Figure : Advanced Waterfall follows V model

Advanced waterfall methodology follows V model in development stages.

## 4.2.2.2 Justification

After some deliberation and discussion the developer settled upon using Waterfall Model for the development of this system. The most tempting factor for selection of Waterfall model is-

* **Stable project requirements**: As in our project most of the user requirements are freeze at the time of PSF so it indicates a stable project requirements and Waterfall methodology completely supports a project which has requirements decided in advance.
* **Progress of system is measurable**: After each step it produces the documentation and as the structure of our Final year project we need to submit the documentation after each phase so it will be best suitable.
* **Strict sign-off requirements**: As the developers goal will be to satisfy the user and until the user will be satisfied the developer will be providing the user desired functionalities and proper features so this methodology will be best suitable.
* The emphasis on requirements and design before writing a single line of code ensures minimal wastage of time and effort and reduces the risk of schedule slippage, or of customer expectations not being met.
* In modified waterfall model life cycle phases are permitted to overlap. Because of the phases overlap, a lot of flexibility has been introduced in the modified waterfall model in software engineering. At the same time, a number of tasks can function concurrently, which ensures that the defects in the software are removed in the development stage itself and the overhead cost of making changes to the software before implementation is saved.
* Making changes to the basic design is also possible, as there are a number of phases active at one point of time. In case there are any errors introduced because of the changes made, rectifying them is also easy (Testing can be done). This helps to reduce any oversight issues. The modified waterfall model diagram does not differ from the traditional waterfall model diagram, as to every phase of the model verification and validation step has been added. (Satalkar, 2010)

## 4.2.3 Algorithms: Why Particular Algorithm?

### 4.2.3.1 Reasons for choosing Genetic Algorithm for Route Planning

* TSP is known as the NP-Complete problem means it cannot be solved in polynomial time, so we need to use an approximation solution that fits right in. Genetic Algorithm is the successful way to approach to get optimized results.
* Testing every possibility for an N city tour would be N! math additions. A 30 city tour would have to measure the total distance of be 2.65 \* 1032 different tours. Assuming a trillion additions per second, this would take 252,333,390,232,297 years. Adding one more city would cause the time to increase by a factor of 31. Obviously, this is an impossible solution.
* Genetic Algorithms mimic nature and evolution using the principles of Survival of the Fittest. Although it might not find the best solution, it can find a near perfect solution for a 100 city tour in less than a minute.
* Greedy approach can be used in between the Genetic algorithm to map closet cities in the initial population generation

### 4.2.3.2 Reasons for choosing Bin Packing Algorithm for Load Planner (CLP)

* 2D-Bin-Packing works on pack a given set of 2D-rectangles into unit square bins so that the number of bins is minimised. Even very simple cases of these problem are known to be NP-hard, and hence, it is very likely that no efficient algorithms for them exist
* In the design of such algorithms, a simple shelf technique is used: order the rectangles according to a sorting rule like decreasing width, increasing height, etc., and then greedily pack them one by one in this order over package shelves according to some rule, like **First-Fit**, **Next-Fit**, **Best-Fit**, **Worst-Fit** and so on. This allows a simple code design, a very fast running time, and a relatively good quality guarantee.
* Beacon has an assumptions that all the **container are of same width**, only the height of containers gets changed, that fixes the width of the rectangle and makes work easier enough in one dimension.

|  |  |
| --- | --- |
| Tall Containers | Container used |
| Figure : Bin Packing Example (Gordon, 2011) | 50x400  50x300  50x200  50x100  50x50 |

## 4.3 Academic Research

There are varied areas in which research has to be accomplished in order to derive some deductions during the development of the proposed system. This system is going to involve all three kinds of research namely, Primary, Secondary and Academic research. Following areas have been shortlisted which needs to researched:

* Key Concepts Genetic Algorithms and Greedy approach
* Concepts of Implementation of Graph theory with data structure
* Bin Packing algorithm and Greedy approach
* Database concepts
* Visual Basic / .NET
* Software Methodology and Software Engineering
* Human Computer Interaction Principles
* Design Pattern

**Books:**

**Algorithms:**

1. Clifford Stein, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest ,2010, *Introduction to Algorithms* ; Massachusetts USA: PHI Learning.
2. David E. Goldberg ,1989, *Genetic Algorithms in search, Optimization & Machine Learning*, 1/e; USA ; Pearson Education
3. Steven Holzner ,2009 *Visual Basic .NET Programming* ;USA; Paraglyph Press

**Software Methodology and Software Engineering**

1. Kendall and Kendall (2005); *System Analysis and Design*; 4th Ed; New York: Prentice Hall.
2. Jeffry L Whittem, Lonnie Bentley (2005). *System Analysis and Design*; London: Mc Graw-Hill.
3. Shelly Cashman (2002). *System Analysis and design*; 2nd Ed. Sydney: Shelly Cashman Series.
4. Shari Lawerence Pfleeger (2002). *Software Engineering*; 2nd Ed; New Jersy: Pearson Education.

# Chapter 5: Research Analysis

## 5.1 Questionnaire Analysis

Refer to appendices for analysis of questionnaire.

## 5.1.1 Questionnaire Conclusion

After analysis of questions, the developer concluded on some points which are following –

Most of the user’s in India are unaware of the situation and complexity, although they area affected. They have no knowledge of the software and its benefits in terms of time and cost cutting.

The developer has decided to provide metaphors for increasing learning ability. Also the application has scope for lots of design principles to increase usability and interaction.

For data entry purpose, developer is not using any advanced database system but a simple excel file or csv file. Also users will be allowed to enter data directly into the application and defining the parameters (e.g. specification of boxes).

Time complexity is the crucial factor in terms of speed, Most of the companies have more than 100 consignments per day, and so without using an advanced approach of solving, the system would be very slow and result into no benefit.

## 5.1.2 Recommendation

Graphical tour generation is motivated by user to showcase the real working of algorithms. Also user can stop running algorithms at any moment.

Since the co-ordinates required for working is very small in size, XML file is recommended to store, edit and change the values of co-ordinates of cities

City Entry ( XML file entry) module required to create co-ordinates so that it can be further used in the algorithms.

Time is crucial factor to solve such big problem, so only the best approach should be applied (like genetic algorithm) to reduce time complexity.

## 5.2 Interview Analysis

Refer to appendices for analysis of Interview.

## 5.2.1 Interview Conclusion

After analysis of Interview, the researcher conclude various points from other interviewee,

Travelling Salesman Problem and Container Loading problem are known as the NP-hard problems and no exact solution is invented yet for this problem. Although real world algorithms like Genetic algorithm, Ant Colony Algorithm, Simulated Annealing are suggested for solving this problem to most optimized state.

Major parameters used in the TSP are the cost calculation, crossover, tournament and mutation factor. Tours are the arrays of cities in a particular order and initial population needs to be created to crossover between them.

## 5.2.2 Recommendation

Initial Parameters used for solving TSP are population Size, mutation %, Random seeds, No of close cities, odd %.

Validation should be provided to check the links between the routes.

Bin Packing Algorithm is suited to the CLP, Next-Fit, First-Fit, Worst-Fit and Best Fit is some loading plans that can be used to get the optimized results.

Both TSP and CLP are NP –complete problems so only the optimized solution can be achieved, no solution for bigger values can be guaranteed as perfect.

## 5.3 Traceability Matrix for Questionnaire and Functionality Mapping

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **RI** | **FC**  **1** | **FC**  **2** | **FC**  **3** | **FC**  **4** | **FC**  **5** | **FE**  **1** | **FE**  **2** | **FE**  **3** | **FS**  **1** | **FS**  **2** |
| **Questionnaires** |  |  |  |  |  |  |  |  |  |  |
| **Q1.6** |  |  |  |  | **X** |  |  |  |  |  |
| **Q1.7** |  | **X** |  | **X** |  | **X** |  |  |  |  |
| **Q1.8** | **X** |  |  |  |  |  |  |  |  |  |
| **Q2.6** |  |  |  |  |  |  | **X** |  |  |  |
| **Q2.7** |  |  |  |  |  |  |  | **X** |  |  |
| **Q2.8** |  |  |  |  |  |  |  | **X** |  |  |
| **Interview** |  |  |  |  |  |  |  |  |  |  |
| **I1** |  | **X** |  | **X** |  |  |  |  |  |  |
| **I2** |  | **X** |  | **X** |  |  |  |  |  |  |
| **I4** |  |  | **X** |  | **X** |  |  |  |  |  |
| **I6** |  |  |  |  |  |  |  |  | **X** |  |
| **I7** |  |  |  |  |  |  |  |  |  | **X** |

Table : Traceability Matrix between Questionnaire, Interviews and Functionalities

# Chapter 6: System Design

The aim of design is to produce a model that will provide a seamless transition to the coding phase, i.e. once the requirements are analysed and found to be satisfactory, a design model is created which can be easily implemented.

**Selected Methodology: Object-oriented design**

In the object-oriented design approach, the system is viewed as collection of objects (i.e. entities). The state is decentralized among the objects and each object manages its own state information. For example, in this project Objects have their own internal data which define their state. Similar objects constitute a class. In other words, each object is a member of some class. Classes may inherit features from super class. Conceptually, objects communicate by message passing.

**Why object-oriented design approach?**

Unlike function-oriented design methods, in OOD, the basic abstraction is not real-world functions such as sort, display, track, etc., but real-world entities such as cities, tour, population etc.

Function-oriented techniques such as SA/SD group functions together if, as a group, they constitute a higher-level function. On the other hand, object-oriented techniques group functions together on the basis of the data they operate on.

**Justification of using these diagrams (object-oriented design Methodology):**

**Use Cases:** Use cases will show who will use the system and what they will do with it. This will specify the system requirements in the context of the user.

**Activity Diagrams:** Activity diagrams will show the flow of work and information between activities performed by users and system or its parts. They elaborate the use cases.

**Sequence Diagrams:** Sequence diagrams will show the sequence of interactions between users and system or its parts. This will help in realizing the structural organization of objects that communicate within a system. **(Kennesaw 2001)**

**Class Diagrams:** UML class diagrams will be used to provide an implementation-independent description of the objects that are used in the system and passed between its components. The design then can be implemented on any platform using any development environment.

**Traceability Matrix between Analysis and Design**

|  |  |  |  |
| --- | --- | --- | --- |
| **Requirement Analysis** | **Design** | | |
| **Use Case** | **Activity Diagram** | **Sequence Diagram** |
| **Design Route Map** | **UC-01** | **AD-01** | **SD-01** |
| **Plan Route** | **UC-02** | **AD-02** | **SD-02** |
| **XML Connection** | **UC-03** | **AD-03** | **SD-03** |
| **Manage Loading** | **UC-04** | **AD-04** |  |
| **View Loading** | **UC-05** | **AD-05** | **SD-04** |
| **Change Language** | **UC-06** | **AD-06** | **SD-05** |
| **Lock** |  |  |  |
| **Image Download** | **UC-03** |  |  |
| **Save/ View** | **UC-02** | **AD-02** |  |

Table : Traceability Matrix between Requirement Analysis and design

### 6.1 Use Cases

With the help of use case diagrams, the developer wishes to discuss and communicate:

* The scenarios in which Beacon will function as a product.
* The goals that it helps those actors achieve.
* The scope/limitations of Beacon.

**The developer’s approach:**

For the benefit of the reader’s the developer has prepared a high-level use-case context diagram with all specifications. After that for each context a full formed use-case is prepared along with any **assumptions, pre-conditions, post-conditions, happy-path, alternate-paths (if any), and exception-pathways**.

Along with the use cases activity diagrams and sequence diagrams are also provided wherever relevant and deemed necessary.

### 6.1.1 Use Case Context Diagram

|  |
| --- |
| C:\Users\r0G3R b1NNy\Desktop\Diagrams\USE CASES\1.Use Case Context Diagram.jpg |

Figure : Use Case Context Diagram

**6.1.1.1 Actor List**

|  |  |
| --- | --- |
| **Actor** | **Description** |
| **User** | Any user who wants to use Beacon for finding shortest path, container loading or Consignment management. |

**6.1.1.2 Use – Case List**

|  |  |  |
| --- | --- | --- |
| **ID** | **Use Case Name** | **Description** |
| UC-01 | **Design Route Map** | Designer for the route map |
| UC-02 | **Plan Route** | Algorithms behind the route and customized output |
| UC-03 | **XML-Connection** | Read /Write to XML file |
| UC-04 | **Manage Loading** | Get elements and helps in choosing best algorithm |
| UC-05 | **View Loading** | View Loading plan in the Graph form |
| UC-06 | **Change Language** | Language Changer |
| UC-07 | **Reports** | Previously Saved Solution Reports |

Table : Use Case List

### 6.1.2 Use Case Specification (Design Route Map)

|  |  |
| --- | --- |
| **Name Design Route Map Use Case ID: UC-01** | |
| **Description:** | Use Case initiates when the user want to design the route in the route map |
| **Goal:** | To be able to create list of cities |
| **Actor(s):** | User |
| **Assumption(s):** | User have the access and knowledge of the application |
| **Pre-condition(s):** | The User has unlocked the application before using |
| **Post-condition(s):** | User can design on picture box/ or import co-ordinates through xml |
| **Primary (Happy) Path:** | |
| The User select create cities   1. User can design cities on the map 2. User can import co-ordinates of cities into the map 3. Cities created must be valid entry 4. Further user can clear out the cities from map 5. Use show graph to view axis. | |
| **Alternate Pathway(s):** | |
| None at the point | |
| **Exception Pathway(s):** | |
| 1. User select xml file but null entry is taken. 2. Cities in xml file are out of scope of the map area. | |

Table : UC-01 Use Case Specification (Design Route Map)

### 6.1.3 UC-01 Use Case Diagram (Design Route Map)

|  |
| --- |
| C:\Users\r0G3R b1NNy\Desktop\Diagrams\USE CASES\3 .Design Route MAp - use case diagram.jpg |

Figure : UC-01 Use Case Diagram (Design Route Map)

|  |
| --- |
| 6.1.4 AD-01 Activity Diagram |
| C:\Users\r0G3R b1NNy\Desktop\Diagrams\Activity Diagram\3.Design Route Map -activity Diagram.jpg |
|  |

Figure : AD-01 Activity Diagram (Design Route Map

|  |
| --- |
| 6.1.5 SD-01 Sequence Diagram (Design Route Map) |
|  |

Figure : SD-01: Sequence Diagram (Design Route Map)

### 6.1.6 UC-02 Use Case (Plan Route)

|  |  |
| --- | --- |
| **Name Plan Route Use Case ID : UC-02** | |
| **Description:** | Use case is applied when the Design route Use Case is successfully done. It is responsible to start algorithm and play with it. |
| **Goal:** | To use the parameter in the best way to determine best path |
| **Actor(s):** | User |
| **Assumption(s):** | Default values of initial constraint are not null.  Algorithm will not stop by own. |
| **Pre-condition(s):** | User have the access of lock and knowledge of the TspForm  User has already the cities list in the array as well as in the map. |
| **Post-condition(s):** | Get the tours which have the best fitness |
| **Primary (Happy) Path:** | |
| The User select Edit Constraints and edit initial parameters like  1. Population Size, Mutation %, Group Size, Max generation, No-of close cities,  Close cities and random seeds.   1. Start button initiates the algorithm and the process start running. 2. Algorithm search for best fitness tour and display it on map. 3. Distance and number of iteration are displayed. 4. Running algorithm can be stopped at any time. 5. After stop, user can edit cities and start algorithm all again. | |
| **Alternate Pathway(s):** | |
| The Running Algorithm can be stopped at any point and initial parameter and cities list can be updated according to needs.   1. After rerunning the algorithm, the algorithm takes all the cities from beginning. 2. Xml file and manual city entry can be done. | |
| **Exception Pathway(s):** | |
| 1. Less than 3 cities cannot come in the process the throw error. 2. New Cities and initial parameter entered are wrong through and error message | |

Table : UC-02 Use Case Diagram (Plan Route)

### 6.1.7 UC-02 Plan Route Map Use Case Diagram

|  |
| --- |
| **C:\Users\r0G3R b1NNy\Desktop\Diagrams\USE CASES\4. Plan Route Map -use case diagram.jpg** |

Figure : UC-02 : Use Case Diagram (Plan Route)

### 6.1.8 AD-02 Activity Diagram (Plan Route)

|  |
| --- |
| **C:\Users\r0G3R b1NNy\Desktop\Diagrams\Activity Diagram\4.Plan Route Map - activity Diagram.jpg** |

Figure : AD-02 Activity Diagram (Plan Route)

### 6.1.9 SD-02 Sequence Diagram (Plan Route)

|  |
| --- |
|  |

Figure : SD-02 Sequence Diagram (Plan Route)

### 6.1.10 UC-03 Use Case Specification (XML Editor)

|  |  |
| --- | --- |
| **Name XML Editor Use Case ID : UC -03** | |
| **Description:** | Use case initiates when user chooses to read/write from xml file. |
| **Goal:** | To use the Xml connection to read cities for the map. |
| **Actor(s):** | User |
| **Assumption(s):** | Xml file should be valid |
| **Pre-condition(s):** | User have the access of lock and knowledge of the TspForm |
| **Post-condition(s):** | Cities list are updated by reading |
| **Primary (Happy) Path:** | |
| 1. User browse the xml file , Load City List , show in map 2. Write co-ordinates to xml file from map | |
| **Alternate Pathway(s):** | |
| 1. None at the point | |
| **Exception Pathway(s):** | |
| 1. Wrong / Invalid File selection | |

Table : UC-03: Use Case Specification (xml editor)

### 6.1.11 UC-03 Use Case Diagram (XML Editor)

|  |
| --- |
|  |

Figure : UC-03 Use Case Diagram (XML Editor)

### 6.1.12 AD-03 Activity Diagram (XML Editor)

|  |
| --- |
| C:\Users\r0G3R b1NNy\Desktop\Diagrams\Activity Diagram\4.1 XML activity.jpg |

Figure :AD-03 Activity Diagram( xml editor)

### 6.1.13 SD-03 Sequence Diagram (xml editor)

|  |
| --- |
|  |

Figure : SD-03 Sequence Diagram (xml editor)

### 6.1.14 UC-04 Use Case Specification (Manage Loading)

|  |  |
| --- | --- |
| **Name Manage loading Use Case ID: UC-04** | |
| **Description:** | Use Case initiates in the ClpForm to solve loading problem |
| **Goal:** | To manage the loading problem by setting elements, algorithm,  Ship length and order of loading. |
| **Actor(s):** | User |
| **Assumption(s):** | 1. ClpForm should be executed 2. Elements are not null. 3. Default Algorithm is Next-Fit Algorithm. 4. Default Ship Length is 80 ft 5. All containers have same length. |
| **Pre-condition(s):** | User have the access of lock and knowledge of the ClpForm |
| **Post-condition(s):** | 1. Ordering of container comes in the bin array in order 2. Initiates View loading Use Case |
| **Primary (Happy) Path:** | |
| In ClpForm, user choose the elements text box   1. Update the container length in the element multi text field. 2. Choose the Ship Length. 3. Select the Algorithm for fitting of containers. 4. Choose the order. 5. Initiates View Loading. | |
| **Alternate Pathway(s):** | |
| None at the point | |
| **Exception Pathway(s):** | |
| User choose the elements text box   1. Container length are not entered in the proper format with space in between 2. Ship length is increased to a very high value. 3. Containers lengths are of very high (infeasible) length. | |

Table : UC-04 Use Case Specification (Manage Loading)

### 6.1.15 UC-04 Use Case Diagram (Manage Loading)

|  |
| --- |
| C:\Users\r0G3R b1NNy\Desktop\Diagrams\USE CASES\6 .Manage Loading use case diagram.jpg |

Figure : UC-04 Use Case Diagram (Manage Loading)

### 6.1.16 AD-04 Activity Diagram (Manage Loading)

|  |
| --- |
| C:\Users\r0G3R b1NNy\Desktop\Diagrams\Activity Diagram\6. manage loading activity diagram.jpg |

Figure : AD-04: Activity Diagram (Manage Loading)

### 6.1.17 UC-05 Use Case Specification (View Loading)

|  |  |
| --- | --- |
| **Name : View Loading Use Case ID: UC-05** | |
| **Description:** | Use Case initiates automatically when manage loading is done |
| **Goal:** | To View the loading Plan of container and reflect changes in the loading in every change of elements, algorithm chosen, ship height and order of loading. |
| **Actor(s):** | User |
| **Assumption(s):** | Every change refreshes the picture box and update graph.  Loading Graph initiates with default initialization.  Height of the Graph is divided into percentage scale. |
| **Pre-condition(s):** | 1.User have the access of lock and knowledge of the ClpForm  2. Elements, Ship length ,order and algorithm are selected |
| **Post-condition(s):** | 1. Elements can be updated at any time 2. Ship length is divided into four parts 0%, 25%, 50%, 75%, 100%. |
| **Primary (Happy) Path:** | |
| User loads the ClpForm   1. Default Loading Graph is shown. 2. Changes reflect with every change in elements, ship length, algorithm and order | |
| **Alternate Pathway(s):** | |
| None at this point | |
| **Exception Pathway(s):** | |
| User load the ClpForm   1. Enter wrong /invalid elements length. | |

Table : UC-05 Use Case Specification (View Loading)

### 6.1.18 UC-05 Use Case Diagram (View Loading)

|  |
| --- |
| C:\Users\r0G3R b1NNy\Desktop\Diagrams\USE CASES\7 . View Loading use case diagram.jpg |

Figure : UC-05 Use Case Diagram ( View Loading)

### 6.1.19 AD-05 Activity Diagram (View Loading)

|  |
| --- |
|  |

Figure : AD-05 Activity Diagram (View Loading)

### 6.1.20 SD-04 Sequence Diagram (View Loading)

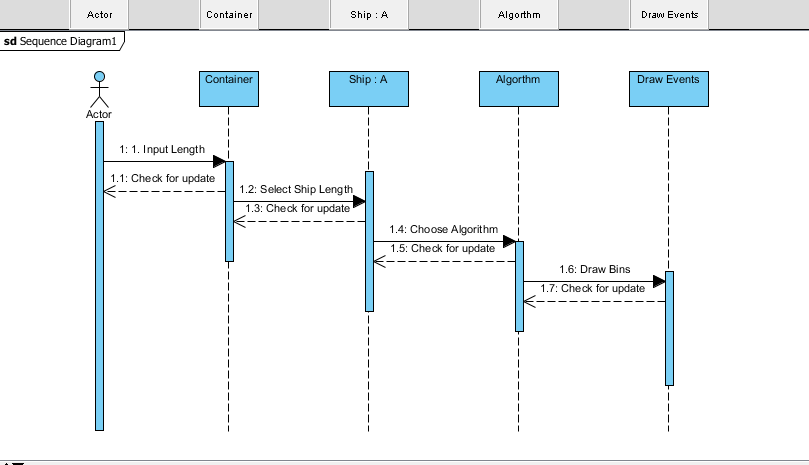


Figure : SD-04 Sequence Diagram (View Loading)

### 6.1.21 UC-06 Use Case Diagram (Change Language)

|  |  |
| --- | --- |
| **Name : Use Case Change Language ID : UC-06** | |
| **Description:** | To Change the Langue |
| **Goal:** | To Choose Language that user requires |
| **Actor(s):** | User |
| **Assumption(s):** | 1. User knows the path of the Menu to change language 2. English is the default language. 3. No third party tools are used |
| **Pre-condition(s):** | User have the access of lock and knowledge of the ClpForm |
| **Post-condition(s):** | Option for English ,French and Hindi |
| **Primary (Happy) Path:** | |
| User navigates to the Help menu bar   1. Move to Change Language 2. Select Language of the Choice 3. Apply Changes | |
| **Alternate Pathway(s):** | |
| 1. Shortcut press – Alt+L 2. Choose language | |
| **Exception Pathway(s):** | |
| None at the point | |

Table : UC-06 Use Case Specification (Change Language)

### 6.1.22 UC-06 Use Case Diagram (Change Language)

|  |
| --- |
| C:\Users\r0G3R b1NNy\Desktop\Diagrams\USE CASES\8 .Change language use case diagram.jpg |

Figure : UC-06 Use Case Diagram (Change Language)

### 5.1.23 AD-06 Activity Diagram (Change Language)

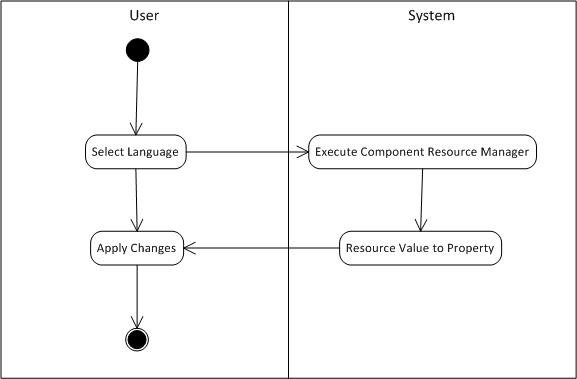


Figure : AD-06 Activity Diagram (Change Language)

### 6.1.24 SD-05 Sequence Diagram (Change Language)

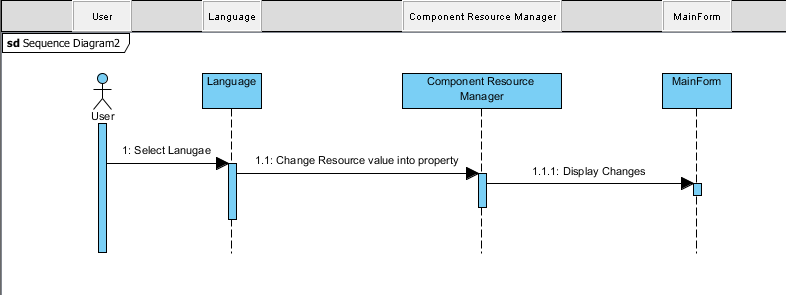


Figure : SD-05 Sequence Diagram(Change Language)

## 6.2 Class Diagrams

|  |
| --- |
|  |

Figure : Class Diagram (Beacon)

## 6.3 Database Design Diagram

### 6.3.1 Data dictionary (TSP)

|  |  |  |
| --- | --- | --- |
| Table No : 1 | | |
| Table Name : TSP | | |
| Description : Saves the final image of TSP into the database | | |
| Attributes | Data type | Description |
| Tsp\_id | Int(identity,100) | Primary key saves unique data with identity. |
| Image | Image | Image type saves image of picture box |
| Date | Date-Time | Date –Time |

### 6.3.2Data Dictionary (CLP)

|  |  |  |
| --- | --- | --- |
| Table No : 2 | | |
| Table Name : CLP | | |
| Description : Saves the final image of CLP into the database. | | |
| Attributes | Data type | Description |
| Tsp\_id | Int(identity,100) | Primary key saves unique data with identity . |
| Image | Image | Image type saves image of picturebox |
| Date | Date-Time | Date –Time |

## 6.4 Test Design

Today, software testing has become very systematic and standard testing techniques are available. Testing activity has also become all-encompassing in the sense that test cases are being developed right from the requirements specification stage. The developer has decided to design the test cases in design phase. The following diagram represents the format of unit testing that will be used to test.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Project Title | | Name of the project | | | | **Date** | Test conducting date | |
| Test Case Name | | Name of the test case | | | | **Test ID** | Id of the test case | |
| Conducted By | | The name of the person who is performing the testing | | | | | | |
| Description | | Description of the test case. | | | | | | |
| MODULE EXECUTION | | | | | | |  |
| No | Steps (Inputs to Module) | | **Result Expected** | **Outputs from Module** | **Result (Pass/Fail)** | | **Corrective Actions** |
| Serial No. | Steps to be executed by tester | | The developer’s expectation’s from the testing | Actual output provided by System | Whether the test fails or pass | | Actions to be taken if actual output doesn’t meet expectations. |
| Conclusion: Whether after corrective actions module works fine or not? | | | | | | | |

Table : Test Plan Sample

The developer has decided to provide following test-cases:-

1. **Login**- It is for user authentication through username & password.
2. **Design Route map**-Basically a picture box used to design the tour
3. **Plan Route**- Algorithm behind the route
4. **Get Container Details**- Container details in the simples using XML
5. **Manage Loading** –Algorithms behind the loading
6. **View Loading** – final Report generation of loading
7. **Change Language** –Language Changer

## Test Plan

|  |
| --- |
| **C:\Users\r0G3R b1NNy\Desktop\Diagrams\Test Plan.jpg** |

Figure : Test Plan PERT chart

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Task ID** | **A1** | **A3** | **A3** | **A4** |
| **Task Details** | Unit Testing | System Testing | Compatibility Testing | Usability Testing |

# Chapter 7: Implementation

This chapter describes the core, enhanced and special functionalities of the Beacon. Design are clearly explains these implementation through designs.

## 7.1 Tools used for Implementation

|  |  |  |
| --- | --- | --- |
| No. | Case Tools/ Development Tool/ Others | Purpose |
| 1 | Microsoft Visio 2007 | To draw all the UML diagrams. |
| 2. | Microsoft Project | To draw Project Gantt chart |
| 3. | Visual Paradigm UML | To draw UML Diagrams |
| 4. | Microsoft Visual Studio 2010 | Used as a primary IDE for functionality, testing. |
| 5. | SQL Server Management Studio | Used as the backend database. |
| 6. | Windows 7 Home Premium | Used as the primary OS to publish software and testing. |
| 7. | .NET Framework version 4 | Framework of development |
| 8. | Microsoft Word 2010 | To document the report. |
| 9. | Microsoft PowerPoint 2010 | To prepare presentation slides. |
| 10. | MS Paint | For image and logo creation. |

Table : Table of Tools Used

### 7.1.1 Implementation Plan

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Task ID** | **A1** | **A2** | **A3** | **A4** | **A5** | **A6** |
| **Task Details** | Implementation Plan | CF-1 | CF-2 | CF-3 | CF-4 | CF-5 |
| **Task ID** | **A7** | **A8** | **A9** | **A10** | **A11** | **A12** |
| **Task Details** | EF-1 | EF-2 | EF-3 | SF-1 | SF-2 | Handover |

|  |  |  |
| --- | --- | --- |
| **Abbreviations** | | |
| **CF-Core Functionality** | **EF-Enhanced Functionality** | **SF-Special Functionality** |

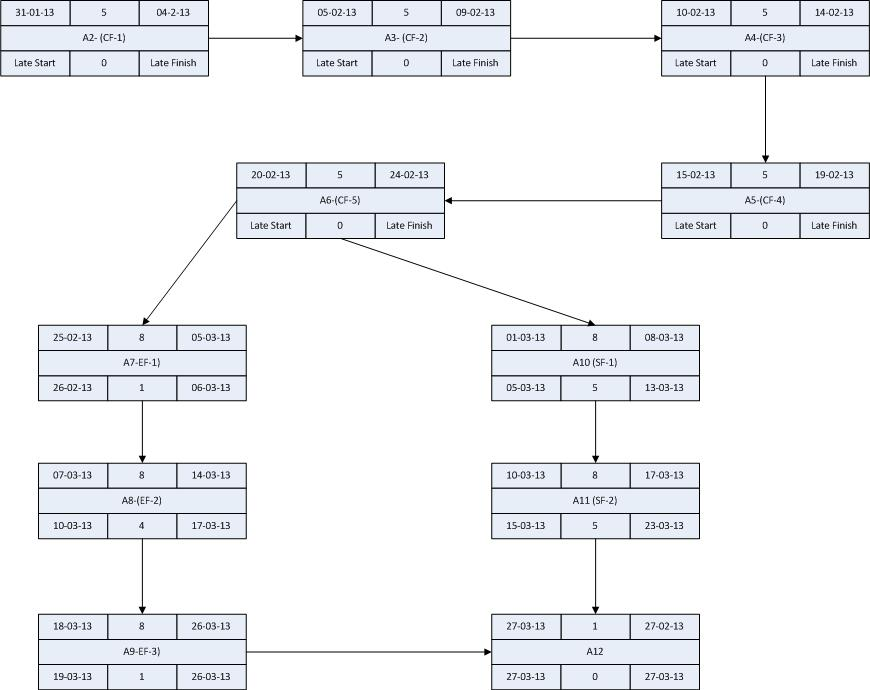


Figure : Implementation Plan

7.2 Implementing Complex Modules

The following sections describe how each module was implemented. In addition to that, each part explains the problems encountered and how they were tackled by the developer. Implementation phase of the entire system was divided as follows for easier and better implementation and maintenance.

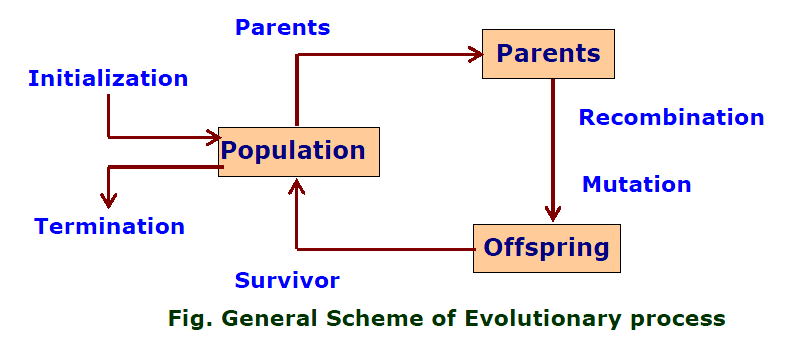


Figure : General Scheme of Evolutionary Process

### 7.2.1 Create Random Population (TSP)

Initialization of population is probably the last of application issues to be solved, thus is not also easy to decide. In TSP, the population is randomly initialized and mixed, but the initialization of population could be more sophisticated task to do and think about. The initial population is base for all further population growth and development, so if the population is initialized incorrectly, e.g. not enough randomized for TSP, then the whole computation is going in wrong way.

### 7.2.1.1 Objective

GA is applied to the certain number of population that includes random cost and constraints to deal with. Mating and crossover is done to the specific chromosomes based on their cost. Tours are the individuals here.

* Create the initial set of random tours of the same cities.
* Choosing a starting point of the tour.
* Prefer choosing a city, the logic is not up to now, but it should be near enough to be chosen.
* Connect the last two cities

### 7.2.1.2 Description: This module basically covers the following subparts:

To begin a GA, we define an initial population of chromosomes. A matrix represents the population with each row in the matrix being a 1 \* array (chromosome) of continuous values.

Equation Equation to create random population

If initial look at this problem with N =13 cities with the fixed starting and ending points, there are a total of  **= 3.1135 \*** possible combinations can be generated. In the Implementation, developer has provided indefinite number of cities to select for and this results in a very large number of possible and unexpected tours.

### 7.2.1.3 Flow of the module:

**Step 1**: Population class inherits the Generic list of Tour that is strongly typed list of objects can be used to sort, search and manipulate. Tour consists the link to the cities in particular order and sub function to use the tour for crossover. Best Available Tour is null during the initiation of population.

|  |  |
| --- | --- |
| Pseudo code | Packages |
| Step1. START  Step2. CREATE Class population  Step 3. Inherit arrayList of tour  Step 4. SAVE private bestTour as NULL  Step 5 GET/SET bestTour to public function  Step 6. Generate Random Population  Step 7. UPDATE bestTour  Step 8. STOP | using System;  using System.Collections;  using System.Collections.Generic;  using System.Text; |

Table : Pseudo code of Population Class

**Step 2**: Random generation of population is done by using three parameters, population size, city list and chance to choose closet city. New tour object is created by counting the total number of cities in the tour array. After this starting and ending point of tour is randomly selected (refer to TSP definition 3.3.1) A random tour is generated using random method and closet city parameters and last tour is first to create a cyclic map.

Then the function determines the Tour Fitness by using tour object. Fitness is the total distance of the tour. Add tour into the population array. If the Tour found has the best fitness, save it as best Tour

|  |  |
| --- | --- |
| Pseudo code | External Class and function used |
| Step 1. START  Step 2. CREATE object of tour of length of city list  Step 3. Randomly select first city  Step 4. FOR EACH city  Step 4.1. DO  Step 4.2. IF new next city , ADD in array  Step 4.3 ELSE ADD random next city  Step 4.4 .END WHILE when next city is last city  Step 4.5 END FOR  Step 5 Connect last two cities using  Step 6 Determine tour fitness  Step 7. ADD tour in the Population  Step 8. IF tour fitness is smaller than best tour fitness  Step 9. REPLACE best tour with tour  Step 10. STOP | **Object**  Tour object is created of size city list  **Functions**  Tour.nextCity  Tour.firstCity  Tour.determineFitness  CityList.CloseCities  Rand.next |

Table : Pseudo code for population and bestTour

## 7.2.2. Crossover (TSP)

Crossover comes after the generation of initial population the GA flowchart. Crossover is done to the parents to create new offspring of better and hybrid cost.

### 7.2.2.1 Objective:

* Perform the crossover operation on two parent tours to create new child tour
* Total of two children will be created so twice execution of the function
* Count links of the cities using iteration
* Take all the common links from both parents and put them in child, this will inherit parent’s traits into child tours.
* Randomly assign remaining links as parent’s link cause multiple disconnected loops in the tour

**7.2.2.2 Description:** The crossover technique used here is much similar as PMX (partially mapped Crossover (**Goldberg, 1985**). A better crossover should introduce new edges to the children and common edges must be inherited. Common edges preserve parent’s traits and new edges provide diversity and escape from local optima.

|  |  |
| --- | --- |
|  |  |
| **Step 1. Decide two crossover points** | **Step 2. Copy path between two crossover point** |
|  |  |
| **Step 3. Copy path of another parent if possible** | **Step 4. Copy remaining path with correspondence** |
|  |  |
| **Step 5. Copy remaining path with correspondance** | **Step 6. Result of PMX** |

Table : Partially Mapped Crossover Demonstration

### 7.2.2.3 Flow of the Module:

**Step 1**: The Shared crossover modules in the Tour have three parameters parent1, parent2 and city list. Basically the module is mathematical selection and manipulation of the link of the city. Tour object is created of size city list to maintain new tour. Calculation of the city link is done through iteration of city list array.

**Step 2**: Parent’s traits are saved as the link that are common to both the parents is also saved in child. To implement this, developer has used iteration of city and then if connection of links of parents are same, save it for next city. Since there are 2 parents and 2 connections, a total of checking will happen. Two offspring are their so, it require to execute this step twice.

**Step 3:** Since parents would cause multiple disconnected loops in the tour. To fill those loops random links are connected to the loops to join cities. Next city will be random city until the flow finds a new city to link to.

|  |
| --- |
| Pseudo code |
| Step 1. START  Step 2. Take parameters as Parent1 , Parent2 and city list  Step 3. CREATE object of Tour  Step 4. FOR EACH city  Step 4.1. SAVE cityusage  Step 4.2. END FOR  Step 5. FOR EACH city  Step 6. IF parent1 connection 1 is EQUALS parent2 connection 1  Step 7. join cities in child connection to next city  Step 8. REPEAT step 6 7 times again  Step 9. FOR EACH city  STEP 9.1. WHILE cityusage is smaller than 2  STEP 9.2. next city EQUALS random city  STEP 10. RETURN child  STEP 11. STOP |

Table : Pseudo Code for Links in Link Class (TSP)

### 7.2.3 Map Editor - GUI Drawing (TSP)

Map Editor Module is the used to showcase the route and the working of algorithm at runtime.

**7.2.3.1 Objective:**

* To Display the cities in the Picture Box of the graph
* Display the routes within the city and algorithm is finding the solution
* Enable to create cities at the mouse click at any co-ordinates.
* Load co-ordinates from XML file
* Can be saved in the image format to be saved in the database

**7.2.3.3 Description:** Map editor is basically a picture box in the system that works on various events. Graphical properties of Picture Box are used to create the map editor.  
It consists of several mouse down event, zooming property, saving property , custom graph creator and other small features.

**7.2.3.4 Flow of the Module:**

**Step 1:** The Map editor start with the loading of picture box. When mouse down events is initiated, the map looks for drawCityList function, City list are created by taking the co-ordinates of picture box in consideration. Also city list can be shown in map by loading it through XML file.

|  |  |
| --- | --- |
| Pseudo Code | Libraries |
| Step 1. START  Step 2. CREATE cityimage EQUALS picturebox  Step 3. DECLARE graphics for cityImage  Step 4. FOR EACH city in citylisy  Step 4.1. DRAW small rectangle  Step 4.2 END FOR  Step 5. RETURN cityimage  Step6. UPDATE city count  Step 7. STOP | using System;  using System.Collections.Generic;  using System.ComponentModel;  using System.Data;  using System.Drawing;  using System.Text;  using System.Windows.Forms;  using System.Threading;  using System.IO;  using System.Globalization; |
| XML file based loading |
| Step 1. START  Step 2. TRIGGER event  Step 3. OPEN file Dialog  Step 4. Filter.xml file  Step 5. IF GET File name  Step 6. OPEN city list from file  Step 7. ELSE  Step 8. PRINT error file not found  Step 9. END IF  Step 10. STOP |

Table 24 :Pseudo code for XML based city loading in map

**Step 2:** After loading the city list, next task is to apply algorithm to generate best possible tour. Developers approaches to show the working of algorithm with the TSP Events. Every New tour in the process is reflected into the map with total distance and routes.

|  |
| --- |
| Pseudo code |
| Step 1 .START  Step 2. GET last best fitness value  Step 3. GET last iteration value  Step 4. next city EQUALS best tour connection1  Step 5. FOR EACH city in city list  Step 5.1. DRAW rectangle for city  Step 5.2. DRAW the line connecting city  Step 5.4. IF last city EQUALS NOT best city connection 1  Step 5.5. next city EQUALS best tour connection 1  Step 5.6. ELSE next city EQUALS best tour connection 2  Step 5.7. END FOR  Step 5.8. RETURN city image  Step 6. STOP |

Table :Pseudo Code for new City generation in pictureBox

|  |
| --- |
|  |

Figure Figure of Running Algorithm of Route Map

## 7.2.4 Container loading Algorithm – Bin Packing Algorithm

Bin Packing is a mathematical way to deal with efficiently fitting Elements into Bins. The hitch is that Bin packing problem is classified as the NP-complete problem. Basically means that there’s no way of being guaranteed the best solution without checking every possible solution

**7.2.4.1 Objective**

* To take the elements as the length of the container
* Apply approach of solving through first fit, next fit, best fit, and worst fit.
* Bin height can be increased and decreased during the execution

**7.2.4.2 Description**

The goal of every Bin Packing algorithm is to use the least amount of Bins to hold the required number of Elements

* **Bin**: The fixed size container that can hold the Elements
* **Bin Height**: The specified amount that each Bin can hold.
* **Element**: An item that is to be placed in a Bin having a certain Element Height
* **Element Height**: The amount of Bin space the Element will take up if placed in that Bin.

**7.2.4.4 Flow of the Module:**

**Step 1**: The first step includes getting the elements from the field and the choice of algorithm to choose for when the event triggered. The decreasing check box apply this algorithm in the decreasing order of array.

|  |  |
| --- | --- |
| Libraries | Pseudo code |
| using System;  using System.Collections.Generic;  using System.ComponentModel;  using System.Data;  using System.Drawing;  using System.Text;  using System.Windows.Forms;  using System.Threading;  using System.IO;  using System.Globalization;  using System.Data.SqlClient; | Step 1: START  Step 2. IF decreasing equals TRUE  Step 2.1. SORT elements  Step 2.2. REVERSE array  Step 2.3. END IF  Step 3 STOP |

Table : Packages used and pseudo code for decreasing order of bins

**Step 2: Next-Fit Algorithm** - This algorithm starts at the beginning of the Elements array and steps through each one. Once Bin 1 is full, it moves on and starts placing elements into Bin 2, never looking back to see if an Element in the future may fit inside Bin 1.

**Step 3: First-Fit Algorithm**: It steps through the Elements sticking them into the first Bin it can, if there aren't any Bins that it will fit into, a new Bin is added. It is more efficient than Next Fit Algorithm.

**Step 4: Worst-Fit Algorithm:** It comes with some extra processing though (on small data sets it doesn't really matter). The only difference between the two algorithms is that Worst Fit picks the Bin with the most amount of free space (or creates a new Bin if no existing one can fit the Element) instead of just picking the first Bin available.

**Step 5: Best-Fit Algorithm:** Instead of picking a Bin with the most amount of free space, this algorithm picks the Bin with the least amount of free space in it that can still hold the current Element. The results you obtain by using this algorithm are not always the same as the Worst Fit, sometimes it is slightly better, other times it is not. It depends on the nature of the data supplied.

|  |
| --- |
| Pseudo Code |
| Step 1. START  Step 2. IF elements equals NULL  Step 2.1. EXIT  Step 3. Declare elements copy, Bin number, Bin Element, Bin count as integer  Step 4. Declare best bin , bin amount ,i , j ,k as integer  Step 5. COPY of array  Step 6. SORT array in descending order  Step 7. FOR EACH element  Step 7.1 best bin and best bin amount EQUALS -1  Step 7.1.1 FOR EACH bin number  Step 7.1.2 bin element =bin(j)  Step 7.1.3 COUNT amount in bin  Step 7.1.4 END FOR  Step 7.2 FIND the most full bin  Step 7.3 RETURN best bin  Step 7.4 END FOR  Step 8. IF best bin equals -1 THEN  Step 9. CREATE new bin  Step 10. Initialise first element to new bin  Step 11. ELSE  Step 12 Place element in the best bin  Step 12 END FOR  Step 13 REMOVE unused elements  Step 14 STOP |
|  |

Table : Pseudo code for Best Fit Algorithm and decreasing order of bin

## 7.3 Problems (Hardest Task)

### 7.3.1 Problem 1: (Mapping TSP with GA and approach of solving)

For solving the route planner problem the developer had to do the following task on the single action

1. Identifying the cost function for the TSP
2. Find the closet city with minimum distance logic
3. Code the chromosome ( as in Genetic Algorithm) of the TSP using data structure.
4. Define fitness function that decide the overall rank of a tour
5. Generate Genetic Algorithm engine for population control and filtering
6. Mating algorithm that do crossover between two parents and generate new offspring.
7. Implement Mutation to reallocate the population from any local extrema
8. Apply right initial parameters.

(Ray, Bandyopadhyay, & Pal, 2004)

**Solution**

1. **Cost Function:** The cost function id determined by the public sub procedures in Cities class. It is basically derived from the Pythagoras Theorem of calculation that is

Equation 2: Distance Calculation

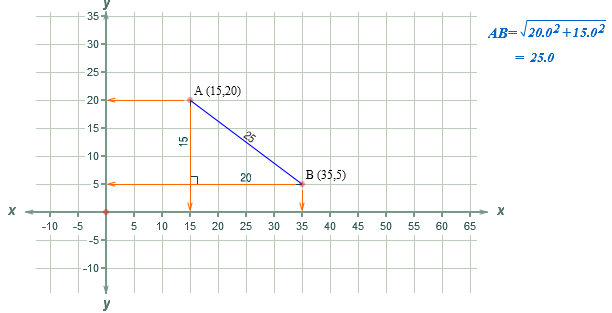


Figure : Distance calculation between two co-ordinates using RMS method

Source: *http://www.mathopenref.com/coorddist.html*

The City distances are calculated for all the cities and further the distance are added to the array list for processing.

1. **Closet city with minimum distance logic:** When creating the initial population of tours, this is a greater chance that a nearby city will be chosen for a link. This is the number of cities that will be considered close

|  |
| --- |
| 1.START  2. FOR EACH i  2.1 FOR EACH cityNum  2.1.1 IF distance of cityNim is smaller then shortest distance THEN  2.1.2 shortest distance EQUALS distance of cityNum  2.1.3 shortest city is cityNum  2.1.4 END IF  2.2 END FOR  2.3 ADD shortest city of closecities array  2.4 END FOR |

Table : Pseudo code for finding the closet city

The final array include the array of the shortest distance to the next city of the all the distances of that city to all other cities. The final values stored in the process are the cities that have the shortest distance.

1. **Map the Chromosomes of TSP for GA**

The chromosome is set of ordered indexes of cities, through which the traveller goes. The TSP is coded into data structure, which can be handed like a chromosome. The array index is our route order, the contents of each array elements is a city number. Hence, if developer wrote the following pseudo code:

A[ ] = { 5 ,64, 23 ,8 , 32 …….. }

It would mean that the visit of city 5 is the starting point followed by city 64, 23, 8, 32 and so on. This is how ‘chromosomes’ or trial solutions is encoded in genetic algorithm. In the code, tour class represents the order of cities linked together and object of the tour class is used to find fitness and other processing in GA.

1. **Fitness Function**

The fitness is calculated for each chromosome that further mates to create new offspring. Fitness is the criteria of ranking the tours. TSP determines fitness as the total distance of a Tour, The higher the distance, lower is the fitness.

Equation : Fitness Equation

Root Mean Square (RMS) value is used to determine fitness from the cost function.

|  |
| --- |
| Public Sub DetermineFitness(ByVal cities As Cities)  Fitness = 0  Dim lastCity As Integer = 0  Dim nextCity As Integer = Me(0).Connection1  For Each link As Link In Me  Fitness += cities(lastCity).Distances(nextCity)  If lastCity <> Me(nextCity).Connection1 Then  lastCity = nextCity  nextCity = Me(nextCity).Connection1  Else  lastCity = nextCity  nextCity = Me(nextCity).Connection2  End If  Next  End Sub |

Table : Fitness Calculation code for each tour

1. **Genetic Algorithm Engine for Population control and Filtering**

Select genetic algorithm engine care about the population, its growth, filtering, selecting and sorting individuals and random mutations of chromosomes. It also handles all the computation process and optionally enables multi-threading processing of the problem.

**Description of Population Generation (Refer to 7.2.1.2)**

**Pseudo code of Population Generation (Refer to 7.2.1.3)**

1. **Mating Algorithm Crossover**

Mating algorithm is very important way, how to create offspring (child) from the parent chromosomes. The task of the mating is to create new offspring, which has characteristics from both parent and improves the quality returned by fitness function. Developer recognises this task as the most difficult and most important as it decides, how well and how fast will the population improve.

**Description of Crossover in GA (Refer to 7.2.2.2)**

**Pseudo code of Crossover in GA (Refer to 7.2.2.3)**

1. **Implement Random Mutation**

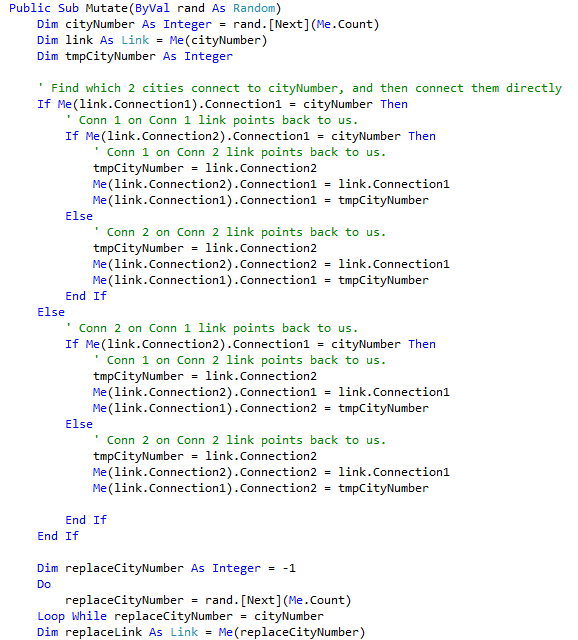
Enable the mating algorithm for moving the population from local extrema. It could happen that the computation is in such a state locked in non-optimal position and needs external (random impulse to break the disability apart a start again moving ahead. The critical factor is that if there is too much of random process into computation, the result will never be the most optimal.

**Description of Mutation in GA**

Random mutations are executed side by side of mating algorithm (crossover) for moving the population from local extrema. It could happen that the computation is in such a state locked in non-optimal position and needs external (random) impulse to break the disability apart an start again moving ahead. On the other hand, if there is too much of random process into computation, the result will never be the most optimal.

Mutation type is Random mutation, developer is changing one of the links in this tour randomly, based on initial mutation % , more links can be changed.

**Code of Mutation in GA**



Random City Location

Mutate  
Sub Procedure

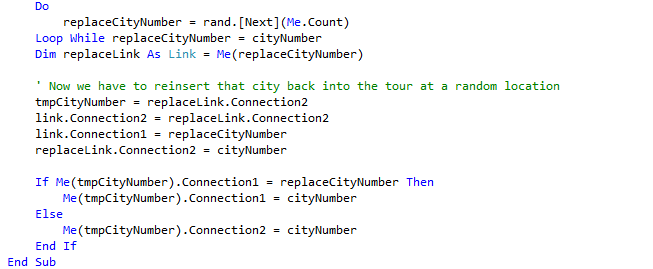


Figure : logic and code of Mutation in GA

1. **Apply the right initial parameters**

The initial parameter includes parameters like population size, size, mutation ratio, population growth. These parameters are relevant to used algorithm, and can influence the computation process a lot.

|  |
| --- |
|  |

Figure : Initial and default parameters of TSP in GA

### 7.3.2 Problem 2 (Generating the Graph of Loading)

The main problem is this to generate the graph on the change event of elements and algorithm selected. The graph of loading is made and control using user control feature of Visual Basic by which custom graphical interfaces can be created and reused. User control is creates by combining controls and components into a user control container and further properties of graph and custom functionality of changes graph are added to extend the functionality of binpackingGraph (Anonynomous, 2003)

For Solving the Container Loading problem, Developer have followed the following steps –

1. Create BinPackingGraph as user control
2. Create Algorithm as Next-Fit, First-Fit, Worst –Fit, Best Fit.
3. Create Drawing methods for BinPacking Graph
4. Select Events to start functions

**Solutions:**

1. **BinPackingGraph as User Control:**  The binPackingGraph2 used in the system basically consists of a picture box named pbDrawingSurface. provide a means by which custom graphical interfaces can be created and reused. A user control is essentially a component with a visual representation. As such, it might consist of one or more Windows Forms controls, components, or blocks of code that can extend functionality by validating user input, modifying display properties, or performing other tasks required by the Developer.

|  |
| --- |
| BinPackingGraph  Drawing Surface |

Figure :Picture Box used as a Drawing Surface by Usercontrol

1. **Algorithms:**  Four different algorithms have been implemented to get the most suitable loading plan.

**(Refer to 7.2.4.4 for Description and Pseudocode)**

Following is the code for Best –Fit Algorithms

|  |
| --- |
| If Bin is Full  Iteration  Sort in Descending order |
| ReDim Preserve Statement  Placing of Elements |

Figure : Code and logic for Best-Fit Algorithm

1. **Drawings Methods**

|  |  |
| --- | --- |
| Bin Gradient  Bin Draw |  |

Figure : Code Snippet from Draw Bins Sub procedure to draw graph

Drawing methods basically consists of four methods in total

|  |  |
| --- | --- |
| Methods | Use |
| Private Sub InitDrawingSurface () | To Create Drawing Surface using graphics libraries |
| Private Function DrawDemaracations ()  As Integer | Returns how wide the text was on the left hand side of the graph as well as draws the Demarcations |
| Private Sub DrawBins() | To actually Draw Bins |
| Private Sub UpdateGraph() | To call DrawBin() ,DrawDemarcations and InitDrawing Surface in case of new graph |

Table : List of methods used in drawing the loading graph

1. **Events**

Developers have provided five events to changing to update graph and re run the algorithm. As elements length, ship length, algorithm and order , all are necessary part of execution, so updateGraph() method is reused in every call .

|  |
| --- |
|  |

Figure : Change events calling compute method

**Events of Value Changes and other in the application ,that makes**

**Algorithm re-run**

## 7.4 Technical Quality

### 7.4.1 Memory Utilization

|  |  |
| --- | --- |
|  |  |

Table : Use of List and Inheritance for memory utilization

List represents a strongly typed list of objects that can be accessed by index. Provides methods to search, sort, and manipulate lists. For utilizing less memory the developer has used ArrayList as it utilizes the memory as required(Dynamically) instead of array that uses fix amount of memory whether that is usable or not.

### 7.4.2 Performance

The application performance is measured in terms of the speed, and time taken to solve the problem, generally termed as the time complexity of algorithm. For upto 100 cities in the tour , application takes less than 30 seconds to approach to the best possible solution in TSP. In loading the output is instant solves and generated graph under a second.

### 7.4.3 User Interface

* User Interface is based on the Human Computer Interaction and Usability Concepts.
* Metaphors are used to increase the usability and understanding.
* Graph are made is very decent way that show each path and route.
* Zoom capability, Co-ordinates can be used to view it in proper way.

### 7.4.4 Short-Cut Keys

For Help F1 , Exit – Alt+f4 key and other set of keys are provided to use so that Beacon can be used as frequently and effectively as user want.

### 7.4.5 Naming Convention

|  |  |
| --- | --- |
| Naming Convention for Class | Naming Convention for Variables |
| Public Class Cities  Inherits List(Of City) | Private bmpGraph As Bitmap  Private DrawingTextBrush As New SolidBrush(Me.ForeColor) |
| Starts with Capital letter | Bmp for bitmap graph |

Table : Showing naming convention used in code

### 7.4.6 Comments

Relevant Comments are provided for better understating of codes and flow within the code

|  |
| --- |
| ''' <summary>  ''' Create the initial set of random tours.  ''' </summary>  ''' <param name="populationSize">Number of tours to create.</param>sn  ''' <param name="cityList">The list of cities in this tour.</param>  ''' <param name="rand">Random number generator. We pass around the same random number generator, so that results between runs are consistent.</param>  ''' <param name="chanceToUseCloseCity">The odds (out of 100) that a city that is known to be close will be used in any given link.</param> |

Table :Showing the used of xml comments to describe code

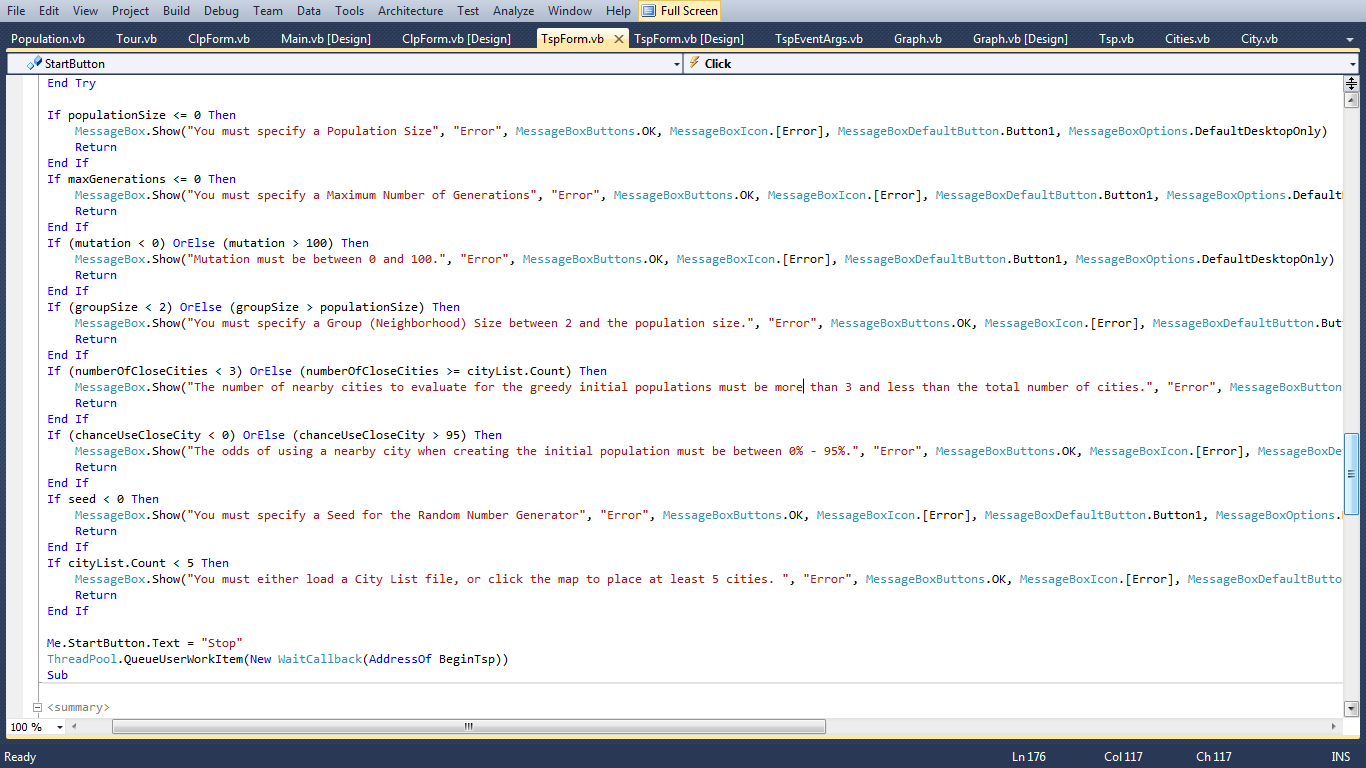
### 7.4.7 Validations

|  |
| --- |
|  |

Figure : Error Message because of less number of cities

Error Message ,

If less than 3 cities



Validation used in TSP Form

Figure : Showing the validations used in TSP

|  |
| --- |
| Another Checking  Test Connection Valid Checks only the valid connections |

Figure : testConnectionValid function determines the validity of clink between cities

### 7.4.8 User Manual

Welcome to the User Manual of Beacon (Hi –Tech Marine Loading and Path Detection System). Run this windows based application in any windows platform by downloading or getting it by other ways. Screen shots are provided below to understand the use of application

|  |
| --- |
|  |
| Step 1: Click on the Setup file to start the application |
|  |
| Step 2: Install The Beacon |
|  |
| Step3: Mouse Down to create cities |
|  |
| Step4: Press Clear City list to clear city |
|  |
| Step 5: Browse City by xml file |
|  |
| Step 6: Click on Open City List to open xml file |
|  |
| Step 7 : Press Start Button to start the Tsp Algorithm |
|  |
| Step 8 : Error Message when Database is not Connected for Saving |
|  |
|  |
| Step9 : Default Elements and Graph at the press |
|  |
| Step 10: Best Fit Algorithm is chosen with Decreasing order |
|  |
| Step 11 : Change Language feature in the menu |
|  |
| Step 12 : Download TSP using and by selecting format of download |

Table : User Manual Table

### Technical Manual

|  |  |
| --- | --- |
|  | |
| Step 1 : Go to file 🡪 New Project 🡪 Choose Visual Basic Windows 🡪 .NET Framework | |
|  |  |
| Step 2. Find User Control in the new menu | |
|  | |
| Step 3: Drag Picture Box onto the User Control | |
|  | |
| Step4 : Go to Debug and then Start Debugging to debug or press shortcut F5. | |
|  | |
| Step 5 : Data Source Configuration Wizard to connect to any database | |

Table : Technical Manual Table

# Chapter 8 Testing

”... we have as many testers as we have developers. And testers spend all their time testing, and developers spend half their time testing. We're more of a testing, a quality software organization than we're a software organization.” – Bill Gates

(Information Week 2002)

Testing is the process of exercising software with the intent of finding and correcting errors. The objective of the testing is to uncover different classes of errors and to do so with a minimum amount of time and effort. In order to provide highly acceptable and error free system, the system should have to face the testing procedure and evaluation of each and every module and functionality.

Testing is the process of executing a program with the intent of finding errors. Once the system is developed, testing will be performed according to test plan. The result of the testing is used for enhancement and correction of the system in the next iteration.

The highlights of this chapter include:

* The different types of testing done.
* The duration taken to test.
* The person(s) involved.
* The reported errors.
* The measures taken.

## Test Plan

Figure : Type of Testing

|  |  |  |
| --- | --- | --- |
| No. | Method | Details |
| 1. | Unit Testing | In this testing activity the developer tested each functionality separately in an isolated manner from the rest of the application |
| 2. | System Testing | Here the developer performed testing on the complete, integrated system. All modules were combined and tested together to evaluate the system’s compliance with the specified requirements. |
| 3. | Compatibility Testing | Developer has tested the application in different windows platform. |
| 4. | User Acceptance Testing | The system was given to a user and he was asked to test the system to check whether the system fulfills the requirement. |
| Assumptions: The Complete Testing process is performed by Developer. | | |

Table : Type of testing involved

## Test Duration

|  |  |  |
| --- | --- | --- |
| **Test Strategy** | **Start Date** | **End Date** |
| **Unit Testing** | 01 April 2013 | 12th April 2013 |
| **System Testing** | 12th April 2013 | 19th April 2013 |
| **Compatibility Testing** | 22 April 2013 | 23rd April 2013 |
| **User Acceptance Testing** | 23th April 2013 | 25th April 2013 |

Table : Test Duration Table

## 8.3 Unit Testing

In order to test each small part of the developed system individual test cases were developed. Unit testing was very helpful as it helped the developer to test individual units of source code.

Two Flavours of unit testing was basically conducted, namely black box (also called functional testing) and white box (also called logical testing).

### 8.3.1 Black Box Testing

|  |  |  |  |
| --- | --- | --- | --- |
| **Project Title** | Beacon 1.0 | **Testing Date** | 01-04-13 |
| **Test Name** | **Beacon Design Route Map** | | |
| **Test ID** | **Beacon-UT-BlackBox-1** | | |
| **Conducted By** | Binit Kumar | | |
| **Description** | Validates the Design and Process of Designing | | |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-UT1 -Test Case #1 | | | |
| Function to Test: | City Design on picture Box | | |
| Execution Steps: | On the **TspForm** picture box mouse down event  Or On the **TspForm** multiple mouse down event  Or On the **TspForm** mouse down when graph checkbox is on | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Small Rectangle of white colour should appear on the map | | Rectangles (Cities) are created in the map | Pass |
| Remarks | | Nil | |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-UT1 -Test Case #2 | | | |
| Function to Test: | Xml file loading in picture box | | |
| Execution Steps: | On browsing xml file  Or On opening XML file containing the city co-ordinates  Or On reading wrong XML file | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Small Rectangle of white colour should appear on the map | | Rectangles are created as per the co-ordinates given in the xml file | Pass |
| Remarks | | The developer has omitted the error that comes , when  wrong xml file gets load and no cities are created, only  file that contains proper co-ordinates in (x, y) fashion can  be read | |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-UT1 -Test Case #3 | | | |
| Function to Test: | Clear and graph | | |
| Execution Steps: | On clearing the city  Or On showing co-ordinate graph to the user when graph checkbox is pressed | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| City in the map are cleared on the clear press, and co-ordinate  Graph is created on graph check | | Cities are cleared and graph is also coming in the proper place | Pass |
| Remarks | | Nil | |

|  |  |
| --- | --- |
| **Conclusion** | |
| **Errors Detected:** | 1 |
| **Measures Taken:** | The code was modified as required and the expected result was achieved. |

|  |  |  |  |
| --- | --- | --- | --- |
| **Project Title** | Beacon 1.0 | **Testing Date** | 02-04-13 |
| **Test Name** | **Beacon Plan Route** | | |
| **Test ID** | **Beacon-UT-BlackBox-2** | | |
| **Conducted By** | Binit Kumar | | |
| **Description** | Check the planning and execution of TSP by using route design, and also check for proper route publishing on the map | | |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-UT2 -Test Case #1 | | | |
| Function to Test: | Initial Constraints default value and edit | | |
| Execution Steps: | On Changing population size textbox value  Or  On Changing mutation % textbox value  Or On Changing group size textbox value  Or On Changing max generation textbox value  Or  On Changing no of close cities textbox value  Or  On Changing random seed textbox value | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Initial values should be loaded in the variable before begin the tsp() function | | Algorithm is showing different  output when the initial values are  changed | Pass |
| Remarks | | Initial values like population size, mutation ,close cities  are kept default but output can vary vastly and positively  When values are updated as per the scenario.  Values are checked by using message box during testing. | |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-UT2 -Test Case #2 | | | |
| Function to Test: | Beginning algorithms | | |
| Execution Steps: | cost function, cost variables and fitness function check  And  Generating initial population in population class  And  Saving Cost of chromosomes (tours) in array  And  Crossover in the Tour class between the tours  And  Mutation to move the execution for any local extema  And  Convergence check | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Algorithm provides the shorter path with every iteration of the algorithm | | Successful shortest distance are  computed with every iteration  but some time *index was out of range*  error is coming | Fail |
| Remarks | | Developer has solved the error as error cannot be  non-negative and also it can’t be smaller than the actual  size of collection. | |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-UT2 -Test Case #3 | | | |
| Function to Test: | Print route in map with every updated shortest tour | | |
| Execution Steps: | On new tour discovery with shortest path in the iteration | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Tour in the map should be updated with every new shortest path finding. | | New tours are updated in the  picture box, but color chosen is not  suitable as per HCI | Pass |
| Remarks | | Colors are changes according to HCI, fast execution of  Algorithm and updated tours are changing within seconds, | |

|  |  |
| --- | --- |
| **Conclusion** | |
| **Errors Detected:** | 1 |
| **Measures Taken:** | The code was modified as required and the expected result was achieved. |

|  |  |  |  |
| --- | --- | --- | --- |
| **Project Title** | Beacon 1.0 | **Testing Date** | 03-04-13 |
| **Test Name** | **Beacon XML read/ write** | | |
| **Test ID** | **Beacon-UT-BlackBox-3** | | |
| **Conducted By** | Binit Kumar | | |
| **Description** | Checks the read/ write activity of the application into the xml files. | | |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-UT3 -Test Case #1 | | | |
| Function to Test: | Reading of city xml file | | |
| Execution Steps: | On Reading of city xml file to load the city list in the graph | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Successful reading of the city.xml file in the array list | | City are saved in the array from the chosen files | Pass |
| Remarks | | Nil | |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-UT3 -Test Case #2 | | | |
| Function to Test: | Writing the co-ordinates of city in the file | | |
| Execution Steps: | On using xml writer to save the city into the xml file | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Successful writing in the file | | Successful format of saving. | Pass |
| Remarks | | Nil | |

|  |  |
| --- | --- |
| **Conclusion** | |
| **Errors Detected:** | 0 |
| **Measures Taken:** | The Xml editor is updated with the interface for proper usabilty |

|  |  |  |  |
| --- | --- | --- | --- |
| **Project Title** | Beacon 1.0 | **Testing Date** | 05-04-13 |
| **Test Name** | **Beacon Manage Container Loading** | | |
| **Test ID** | **Beacon-UT-BlackBox-4** | | |
| **Conducted By** | Binit Kumar | | |
| **Description** | Checks the initial values and loading of the containers | | |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-UT4 -Test Case #1 | | | |
| Function to Test: | Get Elements length in the multi valued textbox | | |
| Execution Steps: | On getting the length in the text box **ClpForm**  Or  On getting more than one value in the text box **ClpForm**  Or  On having text in wrong order in the text box in **ClpForm** | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Successful reading of the text values and array should be updated with every new value | | Array are not getting updated when new values are provided and error is coming index out of range | Fail |
| Remarks | | Redim of the Bin () () is used to change the array size,  Redim is a exclusive feature in the VB and used very  effectively to re define new bin for updated elements. | |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-UT4 -Test Case #2 | | | |
| Function to Test: | Set the ship length ( Box Height) | | |
| Execution Steps: | On incrementing /decrementing the default length of ship i.e. 80 ft | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Ship length is changing and algorithm is taking the new parameter to solve | | Ship length is updated as bin height  And compute() function is called in  The selectindex event | Pass |
| Remarks | | Nil | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Beacon-UT4 -Test Case #3 | | | | |
| Function to Test: | | Next Fit, First Fit, Best Fit, Worst Fit | | |
| Execution Steps: | | On Choosing Next fit,  Or on Choosing First Fit,  Or on Choosing Best Fit,  Or on Choosing Worst Fit. | | |
| Expected Result Actual Result Status(Pass/Fail) | | | | |
| Next Fit – when bin 1 gets full go for bin2 and never checks back  First Fit– Checks all the elements and place it on the first bin it can be  Best Fit- Choose the bin with least amount of free space  Worst Fit- Choose the bin with most amount of free space | | | The outputs are coming  in the proper  Order, All modules working correctly  Next Fit,  Best Fit,  Worst Fit,  Best Fit. | Pass |
| Remarks | Developer have used ReDim Preserve statement many Times, the better  approach is to solve would be to make each Bin Array (the array that holds  the Elements) as big as the Bin Height right at the declaration and then just  chop of the unused (0) elements after the algorithm is done. | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-UT4 -Test Case #4 | | | |
| Function to Test: | Decreasing order | | |
| Execution Steps: | Before applying the algorithm to the elements sort it into decreasing order of array | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| More Efficient packing is done and large elements are placed in the first | | More better packing is coming with  All the algorithm | Pass |
| Remarks | | Nil | |

|  |  |
| --- | --- |
| **Conclusion** | |
| **Errors Detected:** | 1 |
| **Measures Taken:** | The code was modified as required and the expected result was achieved. |

|  |  |  |  |
| --- | --- | --- | --- |
| **Project Title** | Beacon 1.0 | **Testing Date** | 08-04-13 |
| **Test Name** | **Beacon View Loading** | | |
| **Test ID** | **Beacon-UT-BlackBox-5** | | |
| **Conducted By** | Binit Kumar | | |
| **Description** | Graph generation of the bins and box during the change event. | | |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-UT5 -Test Case #1 | | | |
| Function to Test: | Draw Demarcation , how wide the graph is on the left side of the graph | | |
| Execution Steps: | Draw 100% , 75%, 50%, 25% ,0%  And If there decimals, width 2 will be longer  Else width 1 will be longer  Return max width for use | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Left hand side vertical demarcation is shown | | Line is getting updated and changed  When the elements are shown with  Higher elements length | Pass |
| Remarks | | Nil | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Beacon-UT5 -Test Case #2 | | | | |
| Function to Test: | | Draw Ships and Bins | | |
| Execution Steps: | | Draw the vertical line that makes up bins  Draw the gradient  Draw the Bin gradient  Draw the horizontal line with value  Draw the element values  Draw the Bin Number  Draw the Bin Count | | |
| Expected Result Actual Result Status(Pass/Fail) | | | | |
| All the Bins are shown with Gradient, Number, Values, Count and perfectly placed lines. | | | Wrong graph is coming when the  New algorithm is chosen,  Horizontal line is not coming  Bin Count is not coming properly | Fail |
| Remarks | Total Pixel Bin Height was getting a wrong value | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-UT5 -Test Case #3 | | | |
| Function to Test: | Initialize Drawing Surface | | |
| Execution Steps: | Create new bmpgraph as bitmap  Draw graphics  Set Size of bmp Graph same as picturebox  Refresh picture box during update graph call | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| User control is well created and loaded during execution | | Bitmap graph and graphics are working correctly | Pass |
| Remarks | | Nil | |

|  |  |
| --- | --- |
| **Conclusion** | |
| **Errors Detected:** | 1 |
| **Measures Taken:** | The code was modified as required and the expected result was achieved. |

|  |  |  |  |
| --- | --- | --- | --- |
| **Project Title** | Beacon 1.0 | **Testing Date** | 09-04-13 |
| **Test Name** | **Beacon Change Language** | | |
| **Test ID** | **Beacon-UT-BlackBox-6** | | |
| **Conducted By** | Binit Kumar | | |
| **Description** | Language Selected and applied values | | |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-UT6 -Test Case #1 | | | |
| Function to Test: | Change Langue Function | | |
| Execution Steps: | Set Language Property  Call Component resource Manager | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Show the Language Selected | | Showing the language Selected | Pass |
| Remarks | | Nil | |

|  |  |
| --- | --- |
| **Conclusion** | |
| **Errors Detected:** | 0 |
| **Measures Taken:** | Working fine , mdi child forms are also updated |

### White Box Testing

|  |  |  |  |
| --- | --- | --- | --- |
| **Project Title** | Beacon 1.0 | **Testing Date** | 10-04-13 |
| **Test Name** | **Beacon TSP Event Handler** | | |
| **Test ID** | **Beacon-UT-White Box -1** | | |
| **Conducted By** | Binit Kumar | | |
| **Description** | TSP Route Map and Algorithm with Event handler | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| M-Admin-UT7 -Test Case #1 | | | | |
| Function to Test: | Provide appropriate line when algorithm provides the link between the two cities | | | |
| Execution Steps: | On the **TspForm,** picture box is handling the designer. The final tour is mapped in the picture box | | | |
| Expected Result Actual Result Status(Pass/Fail) | | | | |
| Every Tour should be mapped in the picture box with every iteration of the TSP and best fittest value | | | Tours are not coming in the picture box as the algorithm is finding the best suitable value | Fail |
| Code Errors Identified: | | After reviewing the code, the developer have seen that when TspEventArgs class have all the getter and setter value that picture box required and it also inherited the EventArgs class from library System.Drawing, But the error is that after beginning the Algorithm , no Add Handler is added to the function to update the tour diagram. | | |
| **Tested Code:** | | | | |
|  | | | | |
| **Rectified Code:** | | | | |
|  | | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Project Title** | Beacon 1.0 | **Testing Date** | 11-04-13 |
| **Test Name** | **First –Fit Algorithm** | | |
| **Test ID** | **Beacon-UT-White Box 2** | | |
| **Conducted By** | Binit Kumar | | |
| **Description** | First Fit Algorithm | | |

|  |  |  |  |
| --- | --- | --- | --- |
| M-Admin-UT8 -Test Case #1 | | | |
| Function to Test: | First –Fit Algorithm : | | |
| Execution Steps: | On the ClpForm , First-Fit Algorithm can be selected to use  And Select Decreasing to use | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| It steps through the Elements sticking them into the first Bin it can, if there aren't any Bins that it will fit into, a new Bin is added | | First Fit Algorithm is running but the arrays are not getting sorted in between at the tick of decreasing checkbox | Fail |
| Code Errors Identified: | | When Decreasing is True  Array.sort and Array .Reverse syntax in not working | |
| **Tested Code:**  Following code is test and no sorting is happening here | | | |
|  | | | |

|  |
| --- |
| **Rectified Code:**  DeepCopyArray(Elements, ElementsCopy ) function is used to create a new copy incase the module is not working |
|  |
|  |

## System testing

System testing was finally conducted on the complete, integrated system to evaluate the system’s compliance with its set requirements. The purpose of system testing is to validate an application’s accuracy and completeness in performing the functions as designed. System testing simulates real life scenarios in a test environment. (Robda vispe 2004)

System testing is deemed complete when actual results and expected results are either in line or differences are explainable or acceptable based on client input. (Beizer, 1984, p. 24-25)

### 8.4.1 Full System Testing

|  |  |  |  |
| --- | --- | --- | --- |
| **Project Title** | Beacon 1.0 | **Testing Date** | 15-04-13 |
| **Test Name** | **System Testing** | | |
| **Test ID** | **Beacon-ST** | | |
| **Conducted By** | Binit Kumar | | |
| **Description** | Full System Test | | |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-ST1 -Test Case #1 | | | |
| To Test: | Design Route Map | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Mouse Down to Create Cities | | Cities are created | Pass |
| Show Graph Button to show external Graph in map | | Graph is displayed | Pass |
| Browse File to open dialog box and filer xml | | Browse dialog is opening | Pass |
| Load xml file based co-ordinates in map and array | | Cities are loading through xml | Pass |
| Validate Cities | | Validation is running | Pass |
| Clear Button to clear the map | | All Clear | Pass |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-ST1 -Test Case #2 | | | |
| To Test: | Plan Route | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Default Constraints are loading | | Default values | Pass |
| Edit the default values | | Editable | Pass |
| Start Algorithm | | Successful Beginning of TSP | Pass |
| Stop Algorithm at any time | | Stop | Pass |
| Start when validated cities | | Check of Validation is complete | Pass |
| Save Image of map in jpeg, png and gif format | | Successful save of image | Pass |
| Zooming of pictureBox | | Successful | Pass |
| Saving into the Database | | Successful | Pass |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-ST1 -Test Case #3 | | | |
| To Test: | XML Editor | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Xml Reading of co-ordinates | | Reading | Pass |
| Xml file writing | | Writing | Pass |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-ST1 -Test Case #4 | | | |
| To Test: | Manage Loading | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Default load length of containers in the element multivalued textbox | | Loading | Pass |
| Ship Height value | | Default 80 | Pass |
| Select Algorithm | | Successful flow | Pass |
| Decreasing Order | | Selected | Pass |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-ST1 -Test Case #5 | | | |
| To Test: | View Loading | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Initialization of Graph | | Successful | Pass |
| DrawDemarcations | | Showing percentage wise | Pass |
| Draw Bins by the selected elements , algorithm ,order and ship length | | Successful | Pass |
| First-Fit Algorithm | | Working as required | Pass |
| Next-Fit Algorithm | | Working as required | Pass |
| Worst-Fit Algorithm | | Working as required | Pass |
| Best –Fit Algorithm | | Working as required | Pass |
| Update Graph on every event changes | | New Graph is loaded everytime | Pass |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-ST1 -Test Case #6 | | | |
| To Test: | Change Language | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| Language are Selected | | All three can be chosen | Pass |
| Applying Changes | | Successful conversion | Pass |

|  |  |  |  |
| --- | --- | --- | --- |
| Beacon-ST1 -Test Case #7 | | | |
| To Test: | Reports | | |
| Expected Result Actual Result Status(Pass/Fail) | | | |
| View of data from database for TSP | | Successful loading | Pass |
| View of data from database for CLP | | Successful loading | Pass |

|  |
| --- |
| **Conclusion** |
| The developer concludes that the system is working fine and all Project Specification Requirements have been fulfilled with some minor and acceptable changes made. |

## Compatibility Testing

Compatibility testing was conducted on the application to evaluate the application’s compatibility with its computing environment. It was done to make sure that the Beacon application which was till now being tested on a Microsoft Visual Studio would work as expected in a real life environment on a real Application.

|  |  |  |  |
| --- | --- | --- | --- |
| **Project Title** | Beacon 1.0 | **Testing Date** | 16-04-13 |
| **Test Name** | **Compatibility Testing** | | |
| **Test ID** | **Beacon-CT** | | |
| **Conducted By** | Binit Kumar | | |
| **Description** | Compatibility with Windows XP, Windows Vista, Windows 7 and Windows 8 | | |

|  |  |
| --- | --- |
| **Beacon-CT1 -Test Case #7** | |
| **Test Performed** | **Result** |
| Beacon was run on Windows XP | As Expected |
| Beacon was run on Windows Vista | As Expected |
| Beacon was run on Windows 7 | As Expected |
| Beacon was run on Windows 8 | As Expected |
| Beacon was run on Windows Mobile | As Expected |
| Beacon was run on Windows Server | Successful |
| Beacon was run on Windows Ubuntu | By installing Wine, Successful running |

## 8.6 Usability Testing

The system was given to a user and he was asked to test the system to check whether the system fulfils the requirement. (Refer to appendices for Usability questionnaire)

|  |  |
| --- | --- |
| **Question 1** | Do you get proper feedback messages for actions like running status of algorithm, values, connection etc.?  Yes  No  Any other, Specify\_\_\_\_\_\_\_\_\_\_\_\_ |
| **Justification** | This will help to achieve feedback principle in which user gets feedback for every action |
| **Response** |  |
| **Analysis** | As per the user consensus (67% users are in favor), the developer has concluded that feedback principal is achieved. |
| **Question 2** | Whenever you provide any wrong input, do you get proper error messages (validations)?  Yes  No  Any other, Specify\_\_\_\_\_\_\_\_\_\_\_\_ |
| **Justification** | This will help in understanding that input validations are in proper format that user can understand. |
| **Response** |  |
| **Analysis** | As per the user consensus (67% users are in favor), the developer has concluded that validations are successfully implemented and constraints principle is fulfilled. |
| **Question 3** | Do you find color, background & actions of this application, consistent?  Yes  No  Any other, Specify\_\_\_\_\_\_\_\_\_\_\_\_ |
| **Justification** | This will help to achieve consistency principle in which user finds consistency throughout the application |
| **Response** |  |
| **Analysis** | As per the user consensus (67% users are in favor), the developer has concluded that consistency principal is achieved. |
| **Question 4** | Do you get expected behaviors of every action like whenever you zoom perfect zooming happens?  Yes  No  Any other, Specify\_\_\_\_\_\_\_\_\_\_\_\_ |
| **Justification** | This will help to achieve affordance principle in which user finds expected behavior of actions |
| **Response** |  |
| **Analysis** | As per the user consensus (67% users are in favor), the developer has concluded that affordance principal is achieved. |
| **Question 5** | Do you find this system fulfilling the basic functionality (Route Finder, Load Planner) of a social network with advance location concepts GA algorithm and maps and graphs  Yes  No  Any other, Specify\_\_\_\_\_\_\_\_\_\_\_\_ |
| **Justification** | This will help in verifying that system covers all the functionality needed. |
| **Response** |  |
| **Analysis** | As per the user consensus (67% users are in favor), the developer has concluded that System is fulfilling the customer’s need. |
| **Question 6** | Are you able to perform all the activities of this application like (route calculator, best container planner, language change, database connection, xml reader/writer) without asking to anybody, only with the help of user manual?  Yes  No  Any other, Specify\_\_\_\_\_\_\_\_\_\_\_\_ |
| **Justification** | This will help in verifying that user can work independently without any third-party help |
| **Response** |  |
| **Analysis** | As per the user consensus (67% users are in favor), the developer has concluded that user manual guidelines are sufficient to work on the system. |
| **Question 8** | Are you able to read the text and find the controls in proper order & sequence like textboxes and menu options?  Yes  No  Any other, Specify\_\_\_\_\_\_\_\_\_\_\_\_ |
| **Justification** | This will help to achieve visibility & mapping principle in which user is able to find the controls |
| **Response** |  |
| **Analysis** | As per the user consensus (67% users are in favor), the developer has concluded that visibility & mapping principal is fulfilled in the system. |

## 8.7 User Acceptance Testing

User acceptance testing is usually the last stage of the testing process. The question is who is the user? Here the user means the real business users, who will have to operate the system. A developer cannot perform this type of testing he cannot understand the business needs of the system that it must deliver to an organization where it is deployed

The developer contacted Mr. Tanveer Ahmad, a business man of Logistics Chain from Ranchi, to check the features of Beacon and suitability with the scenario. They have tested both the modules and every features according to their needs. The developer also asked Ms. Richa Gupta to test the system for her use in the store for bin packing.

|  |  |  |  |
| --- | --- | --- | --- |
| **Project Title** | Beacon 1.0 | **Testing Date** | 16-04-13 |
| **Test Name** | **Beacon User Acceptance Testing** | | |
| **Test ID** | **Beacon-UAT** | | |
| **Conducted By** | Mr. Tanveer Ahamad , Ms. Richa Gupta | | |
| **Description** | Testing in the real business environment | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Beacon-UAT -1**  **-Test Case #1** | **Mr. Tanveer Ahmad** | | **Ms. Richa Gupta** | |
|  | **Status** | **Excellence %** | **Status** | **Excellence %** |
| Route Map and Designing | Yes | 85% | Yes | 100% |
| Xml Reading and Writing | Yes | 100% | Yes | 98% |
| GA algorithm for TSP | Yes | 100% | Yes | 100% |
| Packing Planning | Yes | 95% | Yes | 80% |
| Efficiency of Packing and Loading | Yes | 100% | Yes | 100% |
| Database Entry | Yes | 100% | Yes | 100% |
| Reports | Yes | 100% | Yes | 85% |

|  |  |  |  |
| --- | --- | --- | --- |
| **Sign Off** | | | |
| **No** | **Name** | **Date** | **Signature** |
| 1 | Mr.Tanveer Ahmand | 1st May 2013 |  |
| 2 | Ms. Richa Gupta | 5th May 2013 |  |

## 8.7 Testing Summary

Testing **Beacon** has been the most tedious of all phases. The developer has invested the maximum effort and time in the testing process. During the testing process a lot errors were identified and subsequently resolved.

According to developers point of view **unit testing** has been the most efficient in terms of errors identified and corrected. The unit testing involved testing the application using black box and white box methods; a large number of black box test cases were produced and the eventual tests were performed.

In the documentation above only those test case descriptions were provided which the developer assumed would be of reading interest to any reader. The white box testing phase was very lengthy and nerve cracking session for the developer as hundreds of lines of codes had to be reviewed and tested numerous times before the final desired outcome was achieved.

**Compatibility testing** turned out to be a difficult task for the developer. A large number of phones with even larger set of platform which changes drastically each day had put the developer in a fix.

# Chapter 9 Critical Evaluation

## 9.1 Introduction

Critical Evaluation of a project is very important. After completion of the various phases of project development it is of utmost important that the developer does the critical evaluation of the complete project module wise.

So, on the completion of the project it was evaluated for the benefits it gives to the targeted end users. How it solves problems of the organization which is not having any such system.

## 9.2 Usefulness of the Beacon for Target Users

**Reduced Complexity of Problem**-.TSP and CLP problems are being solved with the most efficient problem solution being designed and implemented by developer.

**Graphical view of route and container loading** – The system will generate 2D/3D view of the containers to show the best loading graph in CLP and the best route graph in TSP.

**Cost Benefits** - Most efficient route will be produced, results in precious fuel saving hence cost cutting. Best Container loading plan optimizes the overall loading with the ships and also maxims the number of container .Hence this reduces the administration and managerial overhead results into cost benefits

**Time Benefits-** with Beacon, and ships save time by going through the shortest path provided results in more resource availability. For Example: More the trucks reduce the time of travelling; more the loading of trucks will be possible. Also the container loading takes the minimum time in ships.

**Increased work flexibility** Beacon makes it easier to understand the problem statement and to organize and plan the things based on different constraints.

**Approach of Solving:**  Since the algorithms used in Beacon are very advanced and hard to understand, these approaches can be used in various places like, circuit board, neural networks, packing problem, conveyor belt problem etc. The system can also be used for studying about Genetic algorithm for any researcher or programmer.

# Chapter 10 Conclusion

This has been no less than a journey. A year round of work has finally culminated in a beautiful and successful project. Right through the project phase from initiation to completion, a large trove of knowledge and hands on experience has been gained by the developer. The knowledge and experience are surely going to drive and guide the developer to be a more better IT professional and towards a bright future.

At the outset the developer wished to discuss few such things which have till now remained in the back burner, like does the system solve the problem it was supposed to? What limitations have yet remain untouched? Are there any bugs in the final system? What is the future of the software? What are the possible future enhancements? What if the developer was asked to restart the development from scratch, what would be the changes the developer would like to see? What posed as the main computational challenge for the developer and over all discuss his yearlong learning experience.

The developer wishes to answer all these and more one piece at time:

## 10.1 Degree of Success

How are we supposed to measure the degree of success of newly developed software? What is going to be the criteria? According to the developer if the software solves the problem it set out to do, fulfilling all functional requirement then it can be said to be a success.

Now what had the developer in mind when he proposed the system? The vision for Beacon was that:

* A tool which would solves the algorithmic and logical complexity
* A Container Loader tool
* A Fun and nice graph generation for route map and container loading

Basically the developer can say this project successfully met all the requirement stated in the requirement specification and as well as in the project specification form because most of the proposed features and functions have been implemented which as well as including some of the special features. This system correctly implements and fulfils the scope of the project and solved the problem specified.

## 10.2 Limitations and Errors

Developer admits the fact that every system has some limitations and some functionality have been left. Similar is the case with the proposed system. Developer is not able to implement some of the functionality due to time constraints. The list of functions that could have been implemented but were not included in the final system, due to the lack of time, are listed below

* Support on Linux and mobile based operating System
* Synchronisation between application and web module
* Management software with these features

## 10.3 Possible Future Enhancement

Each and every system has many enhancements to do to make system better for the users because no system is perfect. Some of the identified future enhancements are:

* Cloud Based Software (Saas) is in the mind of developer
* Cloud based software can be accessed with profile management by different users
* Module for Mobiles

## 10.4 Main Computational Challenge

The main computational challenge comes while developing this system is:

* Mapping the Genetic Algorithm approach to the Travelling Salesman Problem
* Generating the Graph of the Container Loading Problem
* Crossover and Data Structure mapping for Tours.

## 10.5 Learning Experiences

* Time Management – The most crucial part of any project
* Tools and Techniques – Microsoft visual Studio as a particular tool with VB
* Better Knowledge of Algorithm – Algorithm is all fun that rules the world
* High Motivation – Increased confidence and Positive attitude
* Project Management- Managerial Skill while handling projects.

# References

## Books / Articles and White Paper References

|  |  |
| --- | --- |
| Reference Detail | |
| Bajpai, 2008, *Genetic Algorithm – an Approach to Solve Global Optimization Problems*. Indian Journal of Computer Science and Engineering, 1-3. |
| Beizer, Boris, 1984, Software System Testing and Quality Assurance, 1st Edition, New York, Van Nostrand Reinhold |
| Burnstein, 2002, Practical software testing: A Process-oriented approach, Springer-Verlag, USA |
| B. Chazelle, 1983, *The bottom-left bin packing heuristic: An efficient implementation*. IEEE Transactions on Computers, 32:697--707, |
| Dirk, 2009, *Multi-Objective Container Loading using an Evolutionary Algorithm*. Crawley,University of Western Australia. |
| Haupt, 2004, Practical Genetic Algorithms, 2nd Edition, *The Binary Genetic Algorithm* (p. 28), John Wiley & Sons, Inc, New Jersey |
| Kathy, S 2006, *Information Technology Project Management*, Thompson Course Technology, USA |
| Parre, 1994, *A maximal space Algorithm for container loading problem*, University of Valencia , Spain |
| Petitpieree, Claude, 2006, *Software Engineering: The Implementation Phase,* 1st Edition, Paris, Communication and Information Sciences |
| Pilone, Dan, 2006, *UML 2.0 Pocket Reference,* 1st Edition, O’Reilly Media, New York |
| Pressman, R,S, 2004, *Software Engineering-A Practitioner’s Approach*,5th Edition, Singapore, McGraw-Hill | |
| Ray, Bandyopadhyay, Pal,2004, *New Operators of Genetic Algorithm for Travelling Salesman Problem*, Indian Statistical Institute, Kolkata | |

## Website Reference

|  |
| --- |
| Reference Detail |
| Anand Ramdeo, 2011, White Box Testing. Retrieved 16st April 2011, from <http://www.testinggeek.com/white-box-testing> |
| Anonymous. (2000). Travelling Salesman Problem, Retrieved September 20th Sep 2012, from Travelling Salesman Problem: http://travellingsalesmanproblem.com/ |
| Developer Works, 2001, *UML Basics: The class diagram*, Retrieved 18th February 2011,from <http://www.ibm.com/developerworks/rational/library/content/RationalEdge/sep04/bell/> |
| Gordon, 2011, *CodeInComplete.* Retrieved December 20, 2013, from http://codeincomplete.com/posts/2011/5/7/bin\_packing/example/ |
| Heidi Smith, 2001, *Bin Packing Algorithm,* Retrieved March 20,2013, from  http://users.cs.cf.ac.uk/C.L.Mumford/heidi/BinPacking.html |
| Information Week, 2002, *Q&A: Bill Gates on Trustworthy Computing.* Retrieved 14th April 2011, from <http://www.informationweek.com/news/6502378> |
| Kennesaw, 2001, *Types of UML Diagrams,* Retrieved 16th February 2011, from <http://atlas.kennesaw.edu/~dbraun/csis4650/A&D/UML_tutorial/diagrams.htm> |
| Robdavispe, 2001, What is System Testing, Retrieved 26th April 2011, from  <http://www.robdavispe.com/free2/software-qa-testing-test-tester-2047.html> |
| Slavin, 2011, TED Global 2011. Retrieved September 2012, from http://www.ted.com/talks/kevin\_slavin\_how\_algorithms\_shape\_our\_world.html |
| Vanderburg, 2002, *Glen Vanderburg: Quotations on Software Design,* Retrieved 14th February 2011, from <http://www.vanderburg.org/Misc/Quotes/soft-quotes.html> |
| *Weisstein, 1999, "Traveling Salesman Problem.".* Retrieved on 29th August 2012, from http://mathworld.wolfram.com/TravelingSalesmanProblem.html |