Department for Transport

BRIDGES
UK BRIDGES BOARD

Structures Asset Management Planning Toolkit

Part B: Functional Specification

Version 1.03

June 2014

This document is supported, endorsed and recommended by:

Department for Transport

CIPFA The Chartered Institute of Public Finance & Accountancy

ADEPT
ASSOCIATION OF DIRECTORS OF ENVIRONMENT, ECONOMY PLANNING AND TRANSPORT

BRIDGES
UK BRIDGES BOARD

HAMFIG
Highway Asset Management Financial Information Group

Document Control

DOCUMENT DETAILS:

NAME:	Structures Asset Management Planning Toolkit – Part B: Functional Specification
VERSION:	1.03
OWNER:	UK Bridges Board
PREPARED BY:	Atkins
DATE OF ISSUE:	09 June 2014

VERSION HISTORY:

Version	Purpose Description	Date
0.1	Draft for client comment	19 August 2009
0.2	Draft for client comment	2 September 2011
0.3	Draft – Released for consultation	16 September 2011
0.4	Draft for UKBB Endorsement	28 November 2011
0.5	Draft – Released for Pilot	16 December 2011
1.01	Final for Release	08 May 2012
1.02	Update for 2013: References to valuation period and toolkit version amended Appendix B inserted	05 April 2013
1.03	Update for 2014: References to valuation period and toolkit version amended Reference to 2013 CIPFA Code added	09 June 2014

Acknowledgements

The Structures Asset Management Planning Toolkit has been developed by building on work previously undertaken by the London Bridges Engineering Group (LoBEG). The project has been undertaken by Atkins and overseen by a steering group:

Stephen Pottle (Chair)	Transport for London
Steve Berry (Project Sponsor)	Department for Transport
Andy Bailey	Department for Transport
Paul Hersey	Department for Transport
Mandy Bretherton	Chartered Institute of Public Finance and Accountancy
David Mackenzie	The Highland Council
Graham Bessant	London Underground
Neil Garton Jones	Gwynedd Council
Richard McFarlane	Royal Borough of Kingston upon Thames
Joe Figurado	London Bridges Engineering Group
Ian Sandle	Highways Agency
Liz Kirkham	Gloucestershire County Council
Dr Vicky Vassou	Atkins
Margot Mear	Atkins
Kat Spitieri	Atkins
Lila Tachtsi	Atkins

Project Team

Dr Vicky Vassou	Atkins
Margot Mear	Atkins
Kat Spitieri	Atkins
Lila Tachtsi	Atkins
John Paterson	Atkins

Contents

List of Tables

List of Figures

Appendices

Glossary of Terms

Actors[1-7]	Represent the roles that can be played by the Users of the System. An actor is a person, organisation, or external system that plays a role in one or more interactions with the described system.
Function[8, 9]	A subroutine or subprogram (also called procedure, method, function, or routine) is a portion of code within a larger program, which performs a specific task and is relatively independent of the remaining code. A function is described as a set of inputs, process (i.e. the behaviour), and outputs.
Functional Design[8, 9]	The process of translating the User's needs into a task model that represents the work to be done. Functional design documents the architectural details (i.e. modules, code, etc.) of the system stating **how** the system will be constructed so that it meets the functional specification. The functional design process is a critical first step before any code is written.
Functional Requirement[8, 9]	Calculations, technical details, data manipulation and processing and other specific functionality that define what a system is supposed to accomplish. Behavioural requirements describing all the cases where the system uses the functional requirements are captured in use cases.
Functional Specification[8, 9]	The blueprint which clearly states **what** the proposed system will do.
System	A computerised tool or software.
Use Case[1-7]	A description of a System's behaviour as it responds to a request that originates from outside of that System. A use case describes "who" can do "what" with the System in question. The use case technique is used to capture a System's behavioural requirements by detailing scenario-driven threads through the functional requirements.
Use Case Analysis[1-7]	The most common technique used to identify the requirements of a System.
Use Case Diagram[1-7]	A behavioural diagram defined by and created based on a Use Case Analysis. Its purpose is to present a graphical overview of the functionality provided by a System in terms of Actors, their goals (represented as use cases), and any dependencies between those use cases.

1. Introduction

1.1 General

1.1.1 This document constitutes one part of the *Structures Asset Management Planning Toolkit*. The custodian of this document is the *UK Bridges Board*.

1.1.2 The Structures Asset Management Planning Toolkit comprises:

- Part A: Methodology
- Part B: Functional Specification
- Part C: Supporting Information

1.2 Purpose of the Structures Asset Management Planning Toolkit

1.2.1 The purpose of the *Structures Asset Management Planning Toolkit* is to support bridge engineers and managers in their management and other related activities, for example, financial planning, prioritisation of needs, lifecycle planning and asset valuation. It is anticipated that the toolkit will enable what-if scenarios to be analysed, which would support the decision maker in identifying the appropriate level of funding required for future maintenance, and in doing so ensuring that the predefined performance targets for the structures stock are met.

1.2.2 This version of the toolkit (Version 1.03, June 2014) primarily focuses on long-term asset management and financial planning and asset valuation/depreciation for highway structures.

1.3 Objectives of the Structures Asset Management Planning Toolkit

1.3.1 The objectives of the toolkit, and the requirements and principles that underpin it are:

- To clearly explain the overall methodology and supporting rationale;
- To identify the data and supporting information, i.e. rule sets and algorithms, required to support the methodology and functional specification;
- To ensure the methodology and the functional specification are standalone and independent of any computerised tool, thereby enabling the toolkit to be adopted by different commercial software/systems;
- To enable the methodology, where appropriate, to be adopted in part or in whole to suit the functionality of different commercial software/systems;
- To clearly define the minimum requirements of the methodology and functional specification;
- To enable the methodology and functional specification, where appropriate, to be applied so that the minimum requirements are met by the analysis; and
- To enable the methodology and functional specification, where appropriate, to be refined to support evolving practices over time.

1.4 Background

Asset Management

1.4.1 Asset management is accepted good practice for infrastructure assets. In recent years a number of high profile publications have emphasised the importance of adopting an asset management approach for infrastructure assets, including:

- CSS Framework for Highway Asset Management[10]
- Management of Highway Structures: A Code of Practice[11]

- Maintaining a Vital Asset[12]
- International Infrastructure Management Manual[13]
- PAS 55: Asset Management[14]

1.4.2 In recognition of this, the UK Bridges Board has developed this toolkit to support asset management activities for highway structures.

Accounting Requirements

1.4.3 The UK Government introduced the Whole of Government Accounts (WGA) process to produce a consolidated set of financial statements for the UK public sector. It consolidates around 1,300 bodies, including central government departments, local authorities, devolved administrations, the health service, and public corporations. It is prepared using accounting standards (International Financial Reporting Standards), as adapted and interpreted for the public sector, and is similar in presentation to private sector accounts.

1.4.4 The aim of WGA is to enable Parliament and the public better to understand and scrutinise how taxpayers' money is spent. By presenting the public finances in a framework familiar to the commercial and accountancy professions, WGA increases transparency and accessibility of information about public finances.

1.4.5 CIPFA, on behalf of HM Government, has produced financial planning and accounting guidance for local authority transport infrastructure. CIPFA's *Code of Practice on Transport Infrastructure Assets: Guidance to Support Asset Management, Financial Management and Reporting*[15] supports and aligns with recognised good practice in asset management, providing synergy between asset management, financial planning and accounting. The Code moves the valuation of infrastructure assets from a historic cost basis to a depreciated replacement cost valuation which is consistent with the accounting policy adopted for WGA. An updated version of the Code was published in December 2013[16].

1.4.6 The Structures Asset Management Planning Toolkit meets the accounting requirements presented in the CIPFA Code[15].

1.5 Purpose of Part B

1.5.1 The document sets out functional requirements and specification for the development of the Structures Asset Management Planning System (hereafter referred to as 'the System').

1.5.2 The purpose of this Functional Specification is to describe the functionality and use of the System from the User's perspective, i.e. how the User is going to use the System and what the interactions between the System and the User are. The Functional Specification reflects a collective understanding of the System and as such it does not detail the architecture (i.e. functional design) of the system or how it is going to be implemented. However, in producing this document some consideration was also given to some design issues to ensure a realistic System is specified.

1.6 Functional Requirements

1.6.1 The high-level functional requirements this Functional Specification fulfils are to:

- Describe the functionality which the System should provide, e.g. to support valuation (Gross Replacement Cost and depreciation) and long-term asset management planning for highway structures.
- Provide the information, e.g. rules, assumptions, rationale, algorithms, default data, etc., that may be required by software developers to prepare a detailed functional design.
- Provide a standard against which the System should be tested/validated.

1.7 Layout of the Specification

1.7.1 The layout of the Functional Specification is summarised in Table 01.

Table 01: Layout of the Specification

Section	Contents Description
2. System Outline	This section describes the motivation/need for the system development and lists its most important features and capabilities.
3. Use Cases	This section outlines the Use Cases developed by interested parties. Use Cases included in this section describe the application from the User's point of view and list the sequence of events representing the interaction between the User and the System.
4. Description of Functions	This section describes the complete set of the System's functions with the associated input-process-output arguments.
5. Functional Design Considerations	This section provides a brief description of the operating environment for the System and outlines the System's attributes that may affect the System's functional design.
6. References	Provides a list of relevant documents and other resources referred to for the purposes of this work
Appendices	Provide supporting information including: • Functional Specification Basics • Expanded List of Use Cases • Use Case Basics

2. System Outline

2.1 Overview

2.1.1 This section describes the motivation/need for the system development and lists its most important features and capabilities.

2.2 Need for the System

2.2.1 Over the years authorities have been developing highway asset management plans which have helped to improve services and deliver efficiency savings. Implementation of CIPFA's *Code of Practice on Transport Infrastructure Assets: Guidance to Support Asset Management, Financial Management and Reporting* will provide consistent, high-quality financial information to support effective asset management. The same information used for asset management planning can be also be used to support asset valuation.

2.2.2 In Budget 2008 the Chancellor announced that a Whole of Government Account (WGA) was to be published for the first time in 2009/10. This required a common set of accounting policies for the whole of the public sector.

2.2.3 Local Authority highway infrastructure assets are currently accounted for on a historic cost basis. This is inconsistent with the depreciated replacement cost (DRC) approach that has been adopted as the accounting policy for WGA. It is anticipated that highway infrastructure assets will transition to a current costs DRC basis in the near future.

2.2.4 It is anticipated that this [System] will support valuation (Gross Replacement Cost and depreciation) and long-term management planning for highway structures.

2.3 System Main Features

2.3.1 The main features and capabilities of the system are listed in Table 02 and described in further detail in subsequent sections.

Table 02: System Functionality

Feature No.	Feature Description
Feature 1	Transfer/capture (and store) uploaded data (i.e. inventory, condition, etc.) and/or other input data and information including fixed programmes of work from source files to Investment Planning Module.
Feature 2	Review/amend (and store) structures data (i.e. inventory, condition, etc.) and/or other data and information including fixed programmes that were previously transferred/stored in the Investment Planning Module.
Feature 3	Review/amend (and store) default engineering and maintenance data (i.e. material/component deterioration profiles, intervention thresholds, prioritisation weightings, GRC rates, etc.).
Feature 4	Define analysis parameters (e.g. evaluation/investment period, required performance, condition targets, available budget, maintenance policies, etc.) to set the constraints upon which investment plans will be drawn.
Feature 5	Run the analysis and generate investment plans using the data and parameters.

Feature No.	Feature Description
Feature 6	Review (save/delete/amend) analysis output (i.e. condition indicators, performance trends, expenditure profile, etc.).
Feature 7	View, interrogate and adjust 'Forward Work Plans' (i.e. intervention times and maintenance activity types) resulting from different maintenance strategies for the entire investment period.
Feature 8	Re-run and generate investment plans based on revised structure data, default engineering and maintenance data, analysis parameters and amended interventions decisions data.
Feature 9	View/export/print and compare the results/outputs from running different maintenance strategies and compare outcomes against targets.
Feature 10	Generate outputs that support the development of a funding business case, e.g. Condition Indicators, Performance Trends, Expenditure Profile, Maintenance Shortfall, Consequences, Asset Value, etc.

3. Use Cases

3.1 Overview

3.1.1 This section outlines the Use Cases developed by interested parties which describe the application from the User's point of view and list the sequence of events that represent the interaction between the User and the System.

3.2 List of Use Cases

3.2.1 The Use Cases developed to describe the system from the User's point of view are summarised in Table 03 using the following convention:

- ***ID*** – Use case identifier/reference
- ***Use Case Name*** – High-level name given to this use case
- ***Use Case Goal*** – A few sentences to set out the goal that is to be achieved, placing the use case in context; if a goal cannot be defined then the use case should not exist.
- ***Sequence of Events*** – A high-level description of the sequence of events required to deliver this goal.
- ***MoSCoW[1] Priority***:
  - M - MUST have this;
  - S - SHOULD have this if at all possible;
  - C - COULD have this if it does not affect anything else;
  - W - WON'T have this time but WOULD like in the future.

3.2.2 The extended convention that was used during the Use Case Analysis is contained in Table A.1 in Appendix A while the expanded/detailed list of Use Cases is presented in Appendix B.

[1] A prioritisation technique used in business analysis and software development to reach a common understanding with stakeholders on the importance they place on the delivery of each requirement.

Table 03: List of Use Cases

ID	Use Case Name and Goal	Sequence of Events	MoSCoW Priority
1	**Develop funding business case** Demonstrate the investment required to manage highway structures over the next 30-year period, including all management activities (inspection, maintenance, strengthening, etc.)	• Open Investment Planning Module • Define assumptions and scenario(s), e.g. baseline, Do Minimum, time period, defined performance, defined spend, etc. • Flag fixed works • Run Analysis • View tabular and graphical outputs for condition, performance, spend, risk, asset value etc. at stock level and structure type level • View errors report • Save, delete and/or refine analysis • Compare to other scenarios • Export and/or print reports	M – Must
2	**Develop inspection programme** Confirm programme of structure inspections for any upcoming period or cycle.	• Open Investment Planning Module • Define assumptions • Run Analysis • View tabular and graphical outputs • View errors report • Save, delete and/or refine analysis • Export and/or print reports	W - Won't
3	**Upload data** Easily bulk-upload data in a defined format to inform the analysis, i.e. for generating investment plans	• Open Investment Planning Module • Upload data • Save data	M – Must
4	**Review data** Review input data so that errors can be identified before the analysis is run, i.e. for generating investment plans	• Open Investment Planning Module • Review uploaded data • Upload revised data (if necessary) • Save data	M - Must
5	**Define the evaluation period** Define evaluation period, i.e. how many years will be analysed/included in the investment plan	• Open Investment Planning Module • Input required evaluation period in relevant field • Save input	M - Must
6	**Define targets for structure stock** Define a 'target condition' and a target shortfall for the structure stock to inform 'what-if' analysis/scenarios when generating alternative investment plans	• Open Investment Planning Module • Input targets in relevant field(s) • Save input(s) • Run Analysis	M - Must

ID	Use Case Name and Goal	Sequence of Events	MoSCoW Priority
7	**Define 'required performance'** Define 'required performance' for individual structure and/or group of structures based on construction type and route supported, e.g. to allow flexibility for where there are 'Red Routes'[2] that may be required to meet higher performance targets	• Open Investment Planning Module • Input 'required performance' in relevant field(s) • Save input(s) • Run Analysis	S - Should
8	**Review/amend the default engineering and maintenance data** Review/amend the default values with user-defined values in order to ensure location/authority specific costs are generated in the investment plans	• Open Investment Planning Module • Amend default/values in relevant field(s) • Save input(s) • Run Analysis	M - Must
9	**Amend the prioritisation criteria** Use of prioritisation criteria that are location/authority specific	• Open Investment Planning Module • Amend prioritisation criteria • Amend prioritisation algorithms • Save input(s) • Run Analysis	W - Won't
10	**Amend the prioritisation weightings** Use of prioritisation weightings that are location/authority specific	• Open Investment Planning Module • Amend weightings • Save input(s) • Run Analysis	M - Must
11	**Input fixed programmes of work for selected structures** Input fixed programmes of work for selected structures to override lifecycle analysis in the investment plan	• Open Investment Planning Module • Input fixed programmes of work • Save input(s) • Run Analysis	M - Must
12	**Input fixed programmes of work for selected elements** Input fixed programmes of work for selected element, e.g. programme for parapet/waterproofing replacement(s), to override lifecycle analysis in the investment plan	• Open Investment Planning Module • Input fixed programmes of work • Save input(s) • Run Analysis	W - Won't

[2] 'Red Routes' are major roads in urban areas of the United Kingdom, on which vehicles are not permitted to stop. 'Red Routes' are mainly used on major bus and commuting routes and are marked with red lines at the side of the road. Double red lines mean that the regulations apply at all times and on all days. Single red lines mean that the prohibition applies during times displayed on nearby signs or at the entry to the zone.

ID	Use Case Name and Goal	Sequence of Events	MoSCoW Priority
13	**Input information from lifecycle plans** Input information from individual structures' lifecycle plans to override lifecycle analysis in the investment plan	• Open Investment Planning Module • Input information from individual structures' lifecycle plans • Save input(s) • Run Analysis	C - Could
14	**Select different maintenance policies/strategies** Analyse different maintenance policies/strategies for the defined structure groups and/or individual structures; e.g. Do Minimum, reactive maintenance, preventive maintenance, etc. so that alternative investment plans can be generated and compared	• Open Investment Planning Module • Enable scenarios for different maintenance policies/strategies • Save input(s) • Run Analysis	M - Must
15	**Analyse a wide range of structures** Analyse a wide range of highway structures types, e.g. bridges, retaining walls, culverts, masts, lighting columns, subways, tunnels, etc. so that when prioritisation of funds is considered, the available budget is allocated objectively taking into account the maintenance needs of the entire stock.	• Open Investment Planning Module • Define assumptions and scenario(s), e.g. baseline, Do Minimum, time period, defined performance, defined spend, etc. • Flag fixed works • Run Analysis • View tabular and graphical outputs for condition, performance, spend, risk, asset value etc. at stock level and structure type level • Save, delete and/or refine analysis • Compare to other scenarios • Export and/or print reports	M - Must
16	**Include/analyse a range of maintenance work types** Include/analyse a range of maintenance work types, i.e. routine maintenance, preventive maintenance, strengthening, upgrades, etc. to ensure that all financial needs have been considered in the investment plan	• Open Investment Planning Module • Define assumptions and scenario(s), e.g. baseline, Do Minimum, time period, defined performance, defined spend, etc. • Flag fixed works • Run Analysis • View tabular and graphical outputs for condition, performance, spend, risk, asset value etc. at stock level and structure type level • Save, delete and/or refine analysis • Compare to other scenarios • Export and/or print reports	M - Must

ID	Use Case Name and Goal	Sequence of Events	MoSCoW Priority
17	**Amend interventions decisions** Amend interventions decisions during the analysis at group and/or structure level to account for local factors/knowledge	• Open Investment Planning Module • Define assumptions and scenario(s), e.g. baseline, Do Minimum, time period, defined performance, defined spend, etc. • Flag fixed works • Run Analysis • View tabular and graphical outputs for condition, performance, spend, risk, asset value etc. at stock level and structure type level • Amend/change timing of interventions • Save, delete and/or refine analysis • Compare to other scenarios • Export and/or print reports	M - Must
18	**Group maintenance interventions** Logically group maintenance interventions into schemes	• Open Investment Planning Module • Define assumptions and scenario(s), e.g. baseline, Do Minimum, time period, defined performance, defined spend, etc. • Flag fixed works • Run Analysis • View tabular and graphical outputs for condition, performance, spend, risk, asset value etc. at stock level and structure type level • Save, delete and/or refine analysis • Compare to other scenarios • Export and/or print reports	W - Won't
19	**Calculate depreciated replacement cost (DRC)** Calculate DRC in accordance with accepted financial reporting requirements	• Open Investment Planning Module • Define assumptions and scenario(s), e.g. baseline, Do Minimum, time period, defined performance, defined spend etc. • Flag fixed works • Run Analysis • View tabular and graphical outputs for condition, performance, spend, risk, asset value etc. at stock level and structure type level • Save, delete and/or refine analysis • Compare to other scenarios • Export and/or print reports	M - Must

ID	Use Case Name and Goal	Sequence of Events	MoSCoW Priority
20	**Run analysis with and without routine maintenance** Run analysis with and without routine maintenance	• Open Investment Planning Module • Enable/disable function for the inclusion of Routine Maintenance scenarios for different maintenance policies/strategies • Save input(s) • Run Analysis	M - Must
21	**Present statistics** Present a wide range of statistics (tabular and graphical) per year for the whole analysis period for: • Structure Condition Indicator at stock, group and structure level • Maintenance expenditure profiles: at stock, type/group, structure level; by element type and intervention type, i.e. Revenue vs. Capital • Maintenance shortfall: at stock, type/group, structure level; by element type and intervention type, i.e. Revenue vs. Capital • Consequences (safety or performance at risk, traffic delay, closures, interim measures etc.) at stock, type/group, structure level	• Open Investment Planning Module • View output(s)	M - Must
22	**Save the outputs** Save the outputs of each run so that they can be compared with other runs	• Open Investment Planning Module • Run analysis • View output(s) • Save analysis output(s)	M - Must
23	**Present asset valuation and depreciation outputs** Provide asset valuation and depreciation outputs as required by finance	• Open Investment Planning Module • View output(s)	M - Must
24	**View maintenance strategies** View maintenance strategies (i.e. intervention times and selected treatment) at structure level	• Open Investment Planning Module • View output(s)	M - Must
25	**Output of fixed programmes of works** Output of fixed programmes of works including changes made	• Open Investment Planning Module • View output(s)	M - Must

3.3 Use Cases Diagrams

3.3.1 The Use Cases listed in Table 03 in the previous section describe the interaction between a primary Actor (the initiator of the interaction) and the System itself, represented as a sequence of simple steps. Actors are something or someone which exists outside the system under study, and that takes part in a sequence of activities in a dialogue with the system to achieve a goal. Actors may be end users, other systems, or hardware devices as shown in the Use Cases Diagrams in Figure 1 and Figure 2. A description of the convention and building blocks used in producing the Use Cases Diagrams is provided in Appendix C.

3.3.2 Figure 1 and Figure 2 describe the functionality of the System in a horizontal way, i.e. rather than representing the details of individual features of the System, Use Cases Diagrams are used to show all of its functionality.

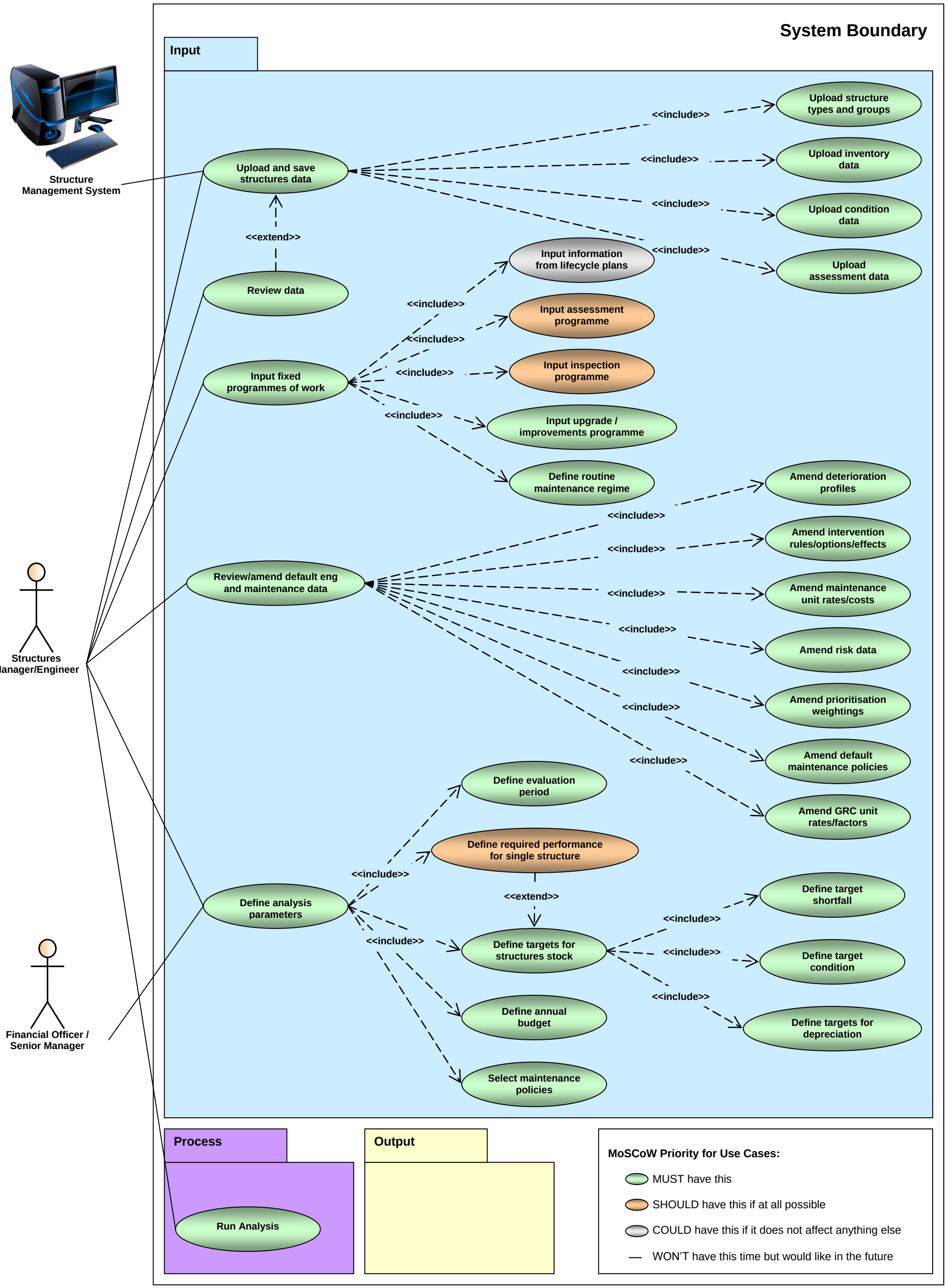


Figure 1: Use Cases Diagram – Input Package

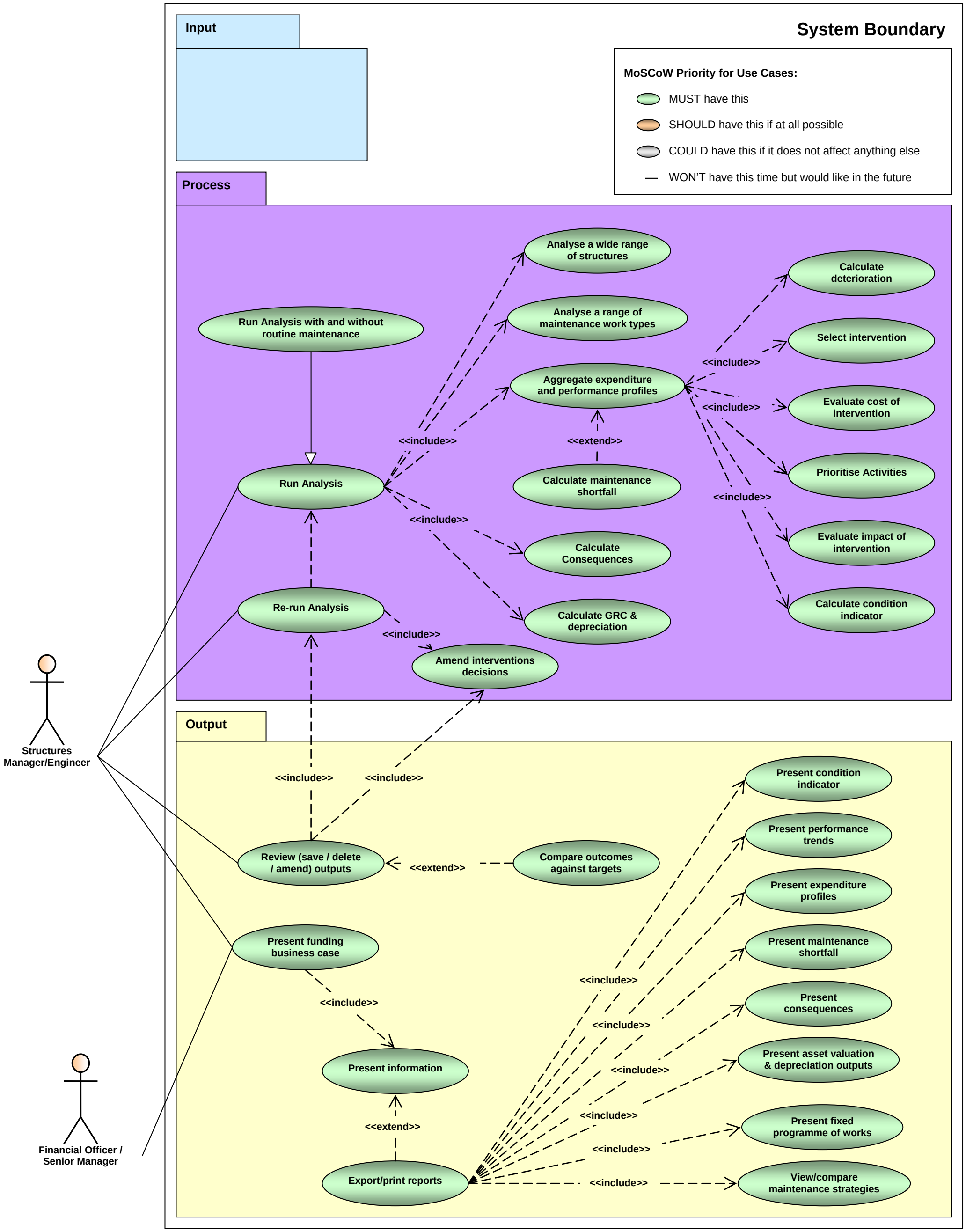


Figure 2: Use Cases Diagram – Process and Output Packages

4. Description of Functions

4.1 Overview

4.1.1 This section describes the complete set of the System's functions with the associated input-process-output arguments.

4.1.2 There is no standard convention for describing functions. However, a widely used approach[8, 9] is to define each function in terms of the following:

- ***Description*** – The purpose of the function
- ***Inputs*** – Input format, module that supplies the input, range of valid inputs
- ***Process*** – The main steps in pseudocode performed by the function
- ***Output*** – The desired output and format, destination for the output
- ***Exceptions*** – Situation when exceptions can occur and the exception handling procedures.
- ***Comments –*** Assumptions, rules and any other considerations

4.2 Function 1 – Input/Upload and Save Structures Data

4.2.1 The function described in Table 04 is based on the Use Cases with ID No. 3, 4, 11, 13 and partly 15 and 16 which are listed in Table 03.

Table 04: Function 1 – Input/Upload and Save Data

Description	Transfer/capture (and store) uploaded data (i.e. inventory, condition, etc.) and/or other input data and information including fixed programmes of work from source files to Investment Planning Module.
Input	Data Input Window/User Interface and Data Upload Script that supports xls, csv, xml, or other suitable file formats for the following data/information: • Structure types – as per those listed in Table 2 of Part A: Methodology[16] • Inventory data – appropriate data fields as listed in the Inspection Proformas included in the Inspection Manual[18] and that allow capturing construction type and dimensions, obstacle crossed, route supported, structure breakdown (see Table 3 of Part A: Methodology[16]), structure usage (i.e. structure location, traffic category) • Condition data – inspection data • Assessment data – assessed capacity, interim measures • Information from lifecycle plans – year/date, type and cost of interventions • Assessment programme – year/date and cost of assessments • Inspection programme – year/date, type and cost of inspections • Upgrade improvements programme – year/date, type and cost of upgrades/improvements • Routine maintenance regime – year/date and cost of routine maintenance activities
Process	• User opens Investment Planning Module • Display Message: "*Start to Input/Upload Data*" with the choice between '*Manual Input*' and '*Bulk Upload*' ***Process 1-1:*** • User manually inputs Structures Data • System displays Input Window/User Interface enabling the User to input the data listed above • User is prompted to save data ***Process 1-2:*** • User selects the bulk-uploading function for uploading Structures Data • Execute Data Upload Script • Display Message: "*Data upload in progress*", with a percentage count-down until the upload process is completed • Display Message: *"The data upload process has been completed successfully. Your data has been saved."*
Output	The result of this operation will be the stored/saved data placed on the server/directory and subsequently displayed in a suitable interface that allows the User to easily locate and review.
Exceptions	A failure is indicated by the "*Data upload failed*" message. This may be due to incorrect data format(s), insufficient disk space, no write access, error in upload script. A failure is indicated by the "*Your data has not been saved. Are you sure you want to exit?*" message. This may be due to the User not saving manually input data and/or attempting to exit the Investment Planning Module, insufficient disk space, no write access, error in upload script.
Comments	Requires robust inventory data and the additional other information and data as listed above.

4.3 Function 2 – Review/Amend Structures Data

4.3.1 The function described in Table 05 is based on the Use Case with ID No. 4 which is listed in Table 03.

Table 05: Function 2 – Review/Amend Structures Data

Description	Review/amend (and store) structures data (i.e. inventory, condition, etc.) and/or other data and information including fixed programmes that were previously transferred/stored in the Investment Planning Module.
Input	Stored Data Window/User Interface allows review/amendment and/or re-entry of structures data such as: • Structure types – as per those listed in Table 2 of Part A: Methodology[17] • Inventory data – appropriate data fields as listed in the Inspection Proformas included in the Inspection Manual[18] and that allow capturing construction type and dimensions, obstacle crossed, route supported, structure breakdown (see Table 3 of Part A: Methodology[1716]), structure usage (i.e. structure location, traffic category) • Condition data – inspection data • Assessment data – assessed capacity, interim measures • Information from lifecycle plans – year/date, type and cost of interventions • Assessment programme – year/date and cost of assessments • Inspection programme – year/date, type and cost of inspections • Upgrade/improvements programme – year/date, type and cost of upgrades/improvements • Routine maintenance regime – year/date and cost of routine maintenance activities
Process	• User opens Investment Planning Module and proceeds with *Reviewing/Amending Stored Structures Data*. • The system displays a Data Summary by structure / structure group • User selects the relevant Structure_Name/Group_Name. • The System displays Detailed Data for each selected structure / structure group stored, including those listed above. • User reviews the stored structures data, and either manually changes or bulk uploads revised data (see Table 04). • User chooses between amending data or maintaining data. • User confirms acceptance and saves any changes.
Output	The result of this operation will be the revised stored/saved structures data placed on the server/directory and subsequently displayed in a suitable interface that allows the User to easily locate and review.
Exceptions	A failure is indicated by the "*Your data has not been saved. Are you sure you want to exit?*" message. This may be due to the User not saving revised data and/or attempting to exit the Investment Planning Module, insufficient disk space, no write access, error in upload script.
Comments	-

4.4 Function 3 – Review/Amend Default Engineering and Maintenance Data

4.4.1 The function described in Table 06 is based on the Use Cases with ID No. 8, 10 and partly 16 which are listed in Table 03.

Table 06: Function 3 – Review/Amend Default Engineering and Maintenance Data

Description	Review/amend (and store) default engineering and maintenance data (i.e. material/component deterioration profiles, intervention thresholds, prioritisation weightings, GRC rates, etc.)
Input	The Default Data Window/User Interface allows review/amendment and entry of default data such as: • Deterioration profiles for materials - i.e. metal, concrete, masonry, etc. • Deterioration profiles for components – e.g. expansion joints, bearings, etc. • Intervention options and triggers, i.e. type of intervention/maintenance activity (e.g. concrete repairs, strengthening, replacement, etc.) and when it could be applied • Intervention effects – element/structure condition following maintenance works • Maintenance rates/costs – fixed, constant and variable works cost • Risk data – penalties e.g. structure with safety or performance at risk and traffic delay • Prioritisation weightings – i.e. weighting coefficients • Default maintenance strategies – i.e. predefined planned preventive strategy, planned targeted strategy, planned do minimum strategy and unplanned reactive strategy • GRC unit rates/factors – replacement unit rates and adjustment factors
Process	• User opens Investment Planning Module and proceeds with *Reviewing/Amending Default Engineering and Maintenance Data*. • The System displays the following options for selection: 1. Material deterioration profiles 2. Component deterioration profiles 3. Intervention options and triggers 4. Intervention effects 5. Maintenance rates/costs 6. Risk data 7. Prioritisation weightings 8. Maintenance policies 9. GRC rates/factors • User selects the specific Default Data that would be reviewed/amended, i.e. one of items No.1 to No. 9. • User selects *'Material deterioration profiles'* to be reviewed. • The System displays the default material deterioration profiles. • User reviews selected default data and either amends or maintains the data. • User confirms acceptance and saves any changes. The same process applies when reviewing/amending any of the items No. 1 to No. 9.
Output	The result of this operation will be the stored/saved revised engineering and maintenance data placed on the server/directory and subsequently displayed in a suitable interface that allows the User to easily locate and review.

Exceptions	A failure is indicated by the *"Your data has not been saved due to missing information."* message. This may be due to the User not saving manually input data and/or attempting to exit the Investment Planning Module, insufficient disk space, no write access, error in upload script, leaving an Entry Box blank.
Comments	The default values e.g. deterioration profiles, were developed by expert opinion and engineering judgement and are based on the underlying assumption that regular routine maintenance is taking place. Where regular maintenance is not systematically undertaken, the profiles should be accelerated.

4.5 Function 4 – Define Analysis Parameters

4.5.1 The function described in Table 07 is based on the Use Cases with ID No. 5, 6, 7 and 14 which are listed in Table 03.

Table 07: Function 4 – Define Analysis Parameters

Description	Define analysis parameters (e.g. evaluation/investment period, required performance, condition targets, available budget, maintenance policies, etc.) to set the constraints upon which investment plans will be drawn.
Input	Parameters Input Window/User Interface that allows the configuration of constraints such as: • Evaluation period, i.e. how many years will be analysed/included in the investment plan • Evaluation intervals, i.e. the length of each time-step in the evaluation period, e.g. 1 year, 5 years, etc. • Budget, i.e. allowable annual budget defined for the entire investment period • Required performance, i.e. condition thresholds for an individual structure and/or group of structures and/or individual elements • Targets, i.e. BCI at structure stock level, target shortfall and depreciation threshold. • Maintenance policies i.e. select one scenario for each alternative analysis run (e.g. planned preventive maintenance, planned targeted maintenance, planned do minimum maintenance and unplanned reactive maintenance)
Process	• User opens Investment Planning Module and proceeds with *Defining Analysis Parameters*. • The System displays the following options: 1. Evaluation period 2. Time-step length 3. Budget 4. Required performance for single structure / stock of structures 5. Targets 6. Maintenance policies • User selects the relevant parameter required to be defined i.e. Evaluation period, Targets, etc.. • User inputs required value (e.g. evaluation period of 30 years and 1-year time-steps) in a User Defined entry function or selects a pre-defined parameter (e.g. planned do minimum maintenance policy). • User is prompted to save parameters. The same process applies when defining items No. 1 to No. 6 The User should be able to select different maintenance policies on either global/stock level or structures group / structures / element level.
Output	The result of this operation will be the stored/saved parameters placed on the server/directory and subsequently displayed in a suitable interface that allows the User to easily locate, review/amend.
Exceptions	A failure is indicated by *"The analysis parameters were not set."* message. This is due to the User not having identified/saved any parameters that would subsequently be used in the analysis.
Comments	At least two maintenance policies/scenarios should be run for a structures stock to enable comparison between different investment plans.

4.6 Function 5 – Run Analysis

4.6.1 The function described in Table 08 is based on the Use Cases with ID No. 15, 16, 19 and 20 which are listed in Table 03.

Table 08: Function 5 – Run Analysis

<table>
<tr><td>Description</td><td colspan="2">Run the analysis and generate investment plans using the data and parameters described in Sections 4.2 to 4.5.</td></tr>
<tr><td>Input</td><td colspan="2">-</td></tr>
<tr><td>Process</td><td colspan="2">• User opens Investment Planning Module and Runs the Analysis.
• The System displays a message: “Do you want to run analysis with or without routine maintenance?” with a choice between ‘Run Analysis with Routine Maintenance’ and ‘Run Analysis without Routine Maintenance’.</td></tr>
<tr><td></td><td>Sub-Process 5-1: Run Analysis with Routine Maintenance
• User Runs Analysis with Routine Maintenance.
• The System runs analysis (as described below).</td><td>Sub-Process 5-2: Run Analysis without Routine Maintenance
• User Runs Analysis without Routine Maintenance.
• The System displays a warning message: “Deterioration profiles have not been configured to account for lack of routine maintenance. Do you still want to proceed with the analysis?” with a choice of ‘Cancel Analysis’ or ‘Proceed with Analysis’.
• The System aborts or runs analysis, respectively.</td></tr>
</table>

	• The System performs the following steps in each year of the investment period. 1. Analyses a range of structures, see *Structures Asset Management Planning Toolkit, Part A: Methodology*[17]*, Table 3.* 2. Calculates material/component deterioration. 3. Selects appropriate intervention (i.e. maintenance activity). 4. Analyses the range of maintenance work types, see *Structures Asset Management Planning Toolkit, Part C: Supporting Information*[19]*, Section 5*. 5. Evaluates cost of intervention. 6. Prioritises maintenance activities in accordance with structures/elements priority scores, as defined in *Structures Asset Management Planning Toolkit, Part A: Methodology*[17], Section 2.12 and Part C*: Supporting Information*[19], Section 11. 7. *Evaluates the impact* of interventions on element/structure condition. 8. Calculates Condition Indicators at element, structure and stock level. 9. Aggregates annual expenditure and performance profiles. 10. Calculates maintenance shortfall. 11. Calculates consequences, i.e. deterioration profiles, expenditure, etc. 12. Calculates GRC and depreciation. • System aggregates the results for the entire investment period. • System displays a message "Analysis Complete. Do you want to save the results?" with the choice between *'Save Now'* and *'Disregard Analysis'.* The process is repeated for every user-defined maintenance strategy (see Function 4). Currently, a prioritisation algorithm is used for the purposes of interventions selection and for funding allocation. However, it is possible that in the future a different form of selection may be required, e.g. optimisation, and as such the system should flexibly allow Users to explore other techniques, should these be required in the future.
Output	The results of this operation will be the stored/saved outputs placed on the server/directory and subsequently displayed in a suitable interface that allows the User to easily locate and review.
Exceptions	A failure is indicated by the "*Analysis has not been complete*d" message. This may be due to insufficient disk space, no write access, error in run script.
Comments	When choosing 'Run Analysis without Routine Maintenance', the User should ensure that this has been taken into account by accelerating relevant deterioration profiles. This could be achieved by either inputting the appropriate percentage at which the values would be accelerated globally, or by manually revising the deterioration profiles for some or all associated elements/structures.

4.7 Function 6 – Review (Save/Delete/Amend) Outputs

4.7.1 The function described in Table 09 is based on the Use Cases with ID No.19, 20, 21, 22, 23, 24 and 25 which are listed in Table 03.

Table 09: Function 6 – Review (Save/Delete/Amend) Outputs

<table>
<tr><td>Description</td><td>Review (save/delete/amend) analysis output (i.e. condition indicators, performance trends, expenditure profile, etc.).</td></tr>
<tr><td>Input</td><td>-</td></tr>
<tr><td>Process</td><td>

Once the analysis is run (see Table 08), the System displays the following:

Condition Indicators
Performance Trends
Maintenance Expenditure Profiles
Maintenance Shortfall
Consequences
Asset Valuation and Depreciation
Programme of Works

User selects the relevant chart/profile requiring review.
User is prompted to save the Analysis Output with the choice between ‘Accept & Save Analysis’ and ‘Disregard Analysis’.

The same process applies for all items from No 1 to No. 7.
<table>
<tr>
<td>Sub-Process 6-1: Accept & Save Analysis

User Accepts & & Saves the Analysis.
System saves the output(s) under a discreet name.
</td>
<td>Sub-Process 6-2: Disregard Analysis

User selects Disregard the Analysis.
System displays a message “Do you wish to exit Investment Planning Module?” with a choice between ‘Yes’ and ‘No’.
System ‘Aborts’ or prompts the User to ‘Save’ the analysis outputs, respectively.
</td>
</tr>
</table>
</td></tr>
<tr><td>Output</td><td>
The results of this operation will be the reviewed/revised stored/saved outputs placed on the server/directory and subsequently displayed in a suitable interface that allows the User to easily locate and review.
The system should break down the results/outputs to the following refinement levels:

Condition Indicators: stock and structure group/type
Performance Trends: stock, structure group/type and element type
Maintenance Expenditure Profiles: stock, structure group/type, element type, intervention type (i.e. Revenue vs. Capital)
Maintenance Shortfall: stock, structure group/type and element type
Consequences: stock and structure group/type
Asset Valuation and Depreciation: stock, structure group/type and element type

The system should allow viewing different maintenance strategies outputs in the same graph(s) to enable comparison.
</td></tr>
<tr><td>Exceptions</td><td>A failure is indicated by the “Data have not been saved.” message. This may be due to insufficient disk space, no write access, error in run script.</td></tr>
<tr><td>Comments</td><td>-</td></tr>
</table>

4.8 Function 7 – Amend Interventions Decisions

4.8.1 The function described in Table 10 is based on the Use Cases with ID No. 17, 24 and 25 which are listed in Table 03.

Table 10: Function 7 – Amend Interventions Decisions

<table>
<tr><td>Description</td><td>View, interrogate and adjust ‘Forward Work Plans’ (i.e. intervention times and maintenance activity types) resulting from different maintenance strategies for the entire investment period.</td></tr>
<tr><td>Input</td><td>User Interface that allows for adjusting system defined work outputs such as:
Intervention times, i.e. at which year / level of element condition to intervene
Maintenance activities, i.e. concrete repairs, replacement, strengthening, etc.</td></tr>
<tr><td>Process</td><td>User opens Investment Planning Module and selects ‘Output File’ as per Function 9.
The System displays ‘Forward Work Plan’ for specific maintenance policy/policies.
‘Forward Work Plan’ is presented in a matrix layout. Blank cells denote no intervention taking place, while enabled cells denote an intervention taking place for each structure type/group at element level for each year of the entire investment period.
User selects relevant ‘Intervention Cell’.
System displays choices to either ‘Reject’ or ‘Move’ each of the interventions or to ‘Cancel’.
<table>
<tr><td>Sub-Process 9-1: Reject Intervention
User rejects an intervention.
System deletes intervention.
User accepts and saves the change.</td><td>Sub-Process 9-2: Move Intervention
User moves an intervention.
The system displays message “Choose to which year you want to move the intervention.”.
User selects the ‘year’ for the intervention to take place.
User accepts and saves the changes.</td><td>Sub-Process 9-3: Cancel Editing
User cancels editing.</td></tr>
</table>
User completes/exits editing mode.
System displays a message “Do you want to save changes done?” with the choice of ‘Accept & Save’ or ‘Reject’.</td></tr>
<tr><td>Output</td><td>The results of this operation will be the reviewed/revised stored/saved outputs placed on the server/directory and subsequently displayed in a suitable interface that allows the User to easily locate and review.</td></tr>
<tr><td>Exceptions</td><td>A failure is indicated by the “Outputs have not been saved.” message. This may be due to insufficient disk space, no write access.</td></tr>
<tr><td>Comments</td><td>Process allows for manually packaging work activities, e.g. two bridges of similar type and construction are located in close proximity. Similar maintenance works have been scheduled for Bridge 1 in 2014 and for Bridge 2 in 2015. User can move maintenance activities for Bridge 2 to 2014 to benefit from combined Traffic Management arrangements.
It is anticipated that the system would operate in one currency, e.g. GBP, but that this can be easily changed to another currency, e.g. from GBP to EUR.</td></tr>
</table>

4.9 Function 8 – Re-Run Analysis

4.9.1 The function described in Table 11 is based on the Use Cases with ID No.17, 19 and 20 which are listed in Table 03.

Table 11: Function 8 – Re-Run Analysis

Description	Re-run and generate investment plans based on revised structure data, default engineering and maintenance data, analysis parameters and amended interventions decisions data.
Input	See Sections 4.2 to 4.5.
Process	As per Function 4 (see Section 4.6).
Output	As per Function 4 (see Section 4.6).
Comments	System should allow for each analysis re-run to be saved under a different name, which could be opened and viewed concurrently in different windows.

4.10 Function 9 – View/Compare Maintenance Strategies

4.10.1 The function described in Table 12 is based on the Use Cases with ID No.19, 20, 21, 22, 23, 24 and 25 which are listed in Table 03.

Table 12: Function 9 – View/Compare Maintenance Strategies

Description	View and compare the results/outputs from running different maintenance strategies and compare outcomes against targets.
Input	-
Process	• User opens Investment Planning Module and *Reviews the saved analysis.* • System displays 'List of Output Files' generated from different runs. • User selects relevant 'Output File Name' and selects it for viewing. • Systems displays analysis outputs as described in Section 4.7. • System allows for more than one Output File to be displayed concurrently in different windows and for the User to compare different maintenance strategies outputs, e.g. by 'dragging-and-dropping' the same type of graphs on top of one another.
Output	The results of this operation will be the stored/saved combined graphical outputs placed on the server/directory and subsequently displayed in a suitable interface that allows the User to easily locate and review.
Exceptions	A failure is indicated by the "*Data are not compatible.*" message. This may be due to the User trying to superimpose dissimilar outputs. A failure is indicated by the "*Data have not been saved.*" message. This may be due to insufficient disk space, no write access.
Comments	-

4.11 Function 10 – Present Funding Business Case

4.11.1 The function described in Table 13 is based on the Use Cases with Ref. No. 1 and 21 which are listed in Table 03.

Table 13: Function 10 – Present Funding Case

Description	Generate outputs that support the development of a funding business case, e.g. Condition Indicators, Performance Trends, Expenditure Profile, Maintenance Shortfall, Consequences, Asset Value, etc..
Input	-
Process	• User opens Investment Planning Module and *loads 'Output File*' (i.e. for alternative Maintenance Strategies) as per Function 7. • User selects '*Export/Print Reports'*. • The System displays output data to choose from including: 1. Condition Indicators 2. Performance Trends 3. Expenditure Profile 4. Maintenance Shortfall 5. Consequences 6. Asset Valuation & Depreciation 7. Fixed Programme of Works 8. Combined outputs of alternative maintenance strategies. • User selects output data to export/print in a required format (e.g. tabular or graphical, print-out paper size, colour, black and white, etc.). • User selects reporting level (e.g. stock, structure type/group, structure or element; capital or revenue; maintenance type, etc.). • User selects the file format in which the data should be extracted, e.g. csv, xml, html, pdf, docm, xlsm, etc. • User selects to either *'Export Data'* or *'Print Data'* . • System 'Exports' or 'Prints' data.
Output	The results of this operation will be exported/printed output data and/or reports.
Exceptions	-
Comments	-

5. Functional Design Considerations

5.1 Overview

5.1.1 This section provides a brief description of the operating environment for the System and outlines the System's attributes that may affect the System's functional design.

5.2 User Community

5.2.1 The system is primarily aimed at Structures Engineers/Managers, who are responsible for generating long-term asset management plans and need to justify decisions in an auditable and robust manner to acquire funding.

5.3 Administration Functions

5.3.1 Access to the model will be handled through an access system based on administrative rights. Different access rights will be administrated depending on the operative's role/level. Operative's roles can be broken down to 'User' and 'Super-User'.

5.4 Error Handling

5.4.1 Errors will be categorised as 'User Error' or 'System Internal Error'. The 'User Error' type, i.e. wrong input, missing information, etc. should be flagged up to the user and dealt with remotely. The System should not allow the User to proceed until all flagged 'User Errors' are rectified. 'System Internal Error', i.e. bugs, should be trapped to the extent possible, giving human-readable output, and, ideally, also any debugging information that can be submitted to the developers.

5.5 Security

5.5.1 The system should allow only one user at a time to be logged on with the same user identity.

5.5.2 A User and/or Unauthorised User should be prohibited from restoring databases or taking backups of any output data not owned by that particular user. Another security fence would also be the inability of a User or Unauthorised User to access files created earlier by the system server running as 'Super-User'.

5.6 Help

5.6.1 The system should provide a help module for Users. It should also provide examples on how to interact with the system for all intended applications/functions.

5.7 Printing

5.7.1 Most printing would be done through a reporting/printing system application, but it would be desirable for Users to print quality flowcharts, tables and graphs with the results of their choice in hard copy or PDF or any other format, as required.

5.8 Interfaces

User Interface

5.8.1 User should be able to interface with the system in a friendly and interactive manner.

Software Interface

5.8.2 The System should be able to interface with any type of application.

5.9 Constraints

5.9.1 A functional system should be the final product of this process, but it is envisaged that future enhancements can be implemented, should the scope of the system change.

5.10 Platforms

5.10.1 The system should support and import/utilise data from any platform.

5.11 Performance

5.11.1 The system would be expected to handle simultaneously multiple users in remote locations. The System maximum run-time should be up to 2 hours.

5.12 Scalability

5.12.1 The system would be expected to support a minimum of 4,000 structures and their associated elements entries. The System should have sufficient and additional processing capacity, should the need to support larger structures stock data or complex modelling problems arise.

5.13 Portability

5.13.1 The system can be designed to be an integral part of an existing system or to be a bolt-on system, in which case it should be designed to be platform independent and have the ability to interface with existing systems.

5.14 Expandability

5.14.1 The system should be coded/configured in such way to allow for future upgrades/changes to functions and procedures and/or adding new function(s)/procedures.

5.15 Support and Maintenance

5.15.1 Provisions should be made for easy upgrades of the system and the appropriate procedures documented.

5.15.2 Arrangements should be made for a help service in support of the use of the system including ‘how to use’ enquires and advice on technical issues.

5.16 Configuration Management

5.16.1 Model versions should be maintained in an open version control system, but easy to install “service packs” should also be available.

5.17 Documentation

Software code should be fully documented. In addition, a functional description should be provided, including a clear and concise description of the System, together with a description of the model scheme and procedures/triggers. Finally, instructions for connecting and operating the System should be provided. Training materials, fully documented with examples, should be also provided.

6. References

1. Kurt Bittner and Ian Spence, Use Case Modelling, Addison Wesley Professional, 2002.
2. A. Cockburn, Writing Effective Use Cases, Addison-Wesley Longman Publishing Co., Inc., 2001.
3. Frank Armour and Granville Miller, Advanced Use Case Modelling: Software Systems, Addison-Wesley Professional, 2000
4. Richard Denney, Succeeding with Use Cases: Working Smart to Deliver Quality, Addison-Wesley Professional, 2005
5. Agile Modelling, Introduction to UML 2 Use Case Diagrams, Published at http://www.agilemodeling.com/artifacts/useCaseDiagram.htm
6. Jason Gorman, Use Cases - An Introduction, Parlez UML, 2006.
7. UML Use Case Diagrams: Tips and FAQs, Published at http://www.andrew.cmu.edu/course/90-754/umlucdfaq.html
8. Syd Chapman & Juri Papay, Functional Specification Template, Open Middleware Infrastructure Institute, University of Southampton, 2005.
9. Dino, Fancellu, Functional Specification Standard, Published at http://www.softwarereality.com/lifecycle/functionalspec.jsp
10. CSS Framework for Highway Asset Management, 2004
11. Management of Highway Structures: A Code of Practice, TSO, 2005
12. Maintaining a Vital Asset, 2005
13. International Infrastructure Management Manual, 2006.
14. PAS 55: Asset Management, Specification for the Optimized Management of Physical Assets, BSi, 2008.
15. Code of Practice on Transport Infrastructure Assets: Guidance to Support Asset Management, Financial Management and Reporting, CIPFA, 2010
16. Code of Practice on Transport Infrastructure Assets: Guidance to Support Asset Management, Financial Management and Reporting, CIPFA, 2013
17. Structures Asset Management Planning Toolkit, Part A: Methodology, Version 1.03, 2014
18. Inspection Manual for Highway Structures, Volume 1: Reference Manual, TSO, 2007.
19. Structures Asset Management Planning Toolkit, Part C: Supporting Information, Version 1.03, 2014.

Appendix A. Functional Specification Basics

A.1. Functional Specification for the Structures Asset Management Planning Toolkit

Prepared by Atkins
08 June 2009

A.1.1. Introduction

This note has been prepared by Atkins to facilitate discussion and agreement on the functional specification of the Structures Asset Management Planning Toolkit.

A.1.2. Background

The UK Bridges Board, CSS Bridges Board, Department for Transport and CIPFA have agreed that the LoBEG work on Asset Management Planning for highway structures provides a sound starting point for the development of a nationally accepted methodology that:

- Supports long-term asset management planning for highway structures; and
- Provides the necessary information for robust financial accounting and depreciation.

A.1.3. Objective

The objective of this functional specification is to provide a clear statement of how the *Structures Asset Management Planning Toolkit*[3] will look and work. This includes, but is not limited to:

- ***Management of Highway Structures*** – what functional capability and outputs must be provided with regard to management?
- ***Financial Accounting Information*** – what financial accounting information must be provided and in what format/level of granularity?
- ***Systems Integration*** – what software systems does it need to link to, for example, in terms of inputs and outputs?
- ***Technical Environment*** – what Information Management/Technology polices, standards and guidelines must be adhered to; plus any technology specifications?

A.1.4. Approach

The functional specification will be developed through the 'Use cases' technique. Section A.1.2 describes the purpose of the functional specification and how 'Use cases' are used to elicit views and opinions on the capability/functionality of the *Structures Asset Management Planning Toolkit*, these will be used as the basis for drafting the functional specification.

Important: Under the current commission, it is the intention to develop a *Toolkit* which will detail the approach, methodology, algorithms etc. and an interim computerised tool using MS Excel. The *Toolkit* will enable any software provider to produce the software. Therefore, the *Functional Specification* must set down the requirements of the final solution (i.e. that to be implemented into formal Bridge Management Systems) and not be restricted by the limitations of the MS Excel interim solution.

[3] Toolkit – covers the documentation and computerised tools that will support asset management and financial planning for highway structures.

A.1.5. Functional Specification

A.1.5.1. What is it?

In simple terms, a functional specification is the blueprint for how an application should look and work; the functional specification sets down:

- What the finished application will do;
- How a user will interact with the application; and
- What the application will look like.

A.1.5.2. Why write one?

By creating the blueprint of the application upfront, resources are saved during development because it can progress on the basis of agreed end-user logic; i.e. ideally, the developers have all the key questions already answered about how the application will look and work.

The functional specification also provides all parties with an agreed documentation of what is to be delivered.

A.1.5.3. Who produces it?

The functional specification should be produced as a fully collaborative exercise between the developers and the end users. In particular all parties must put appropriate effort into 'imagining' how an end-user might use the application, i.e. in order to ensure the application meets the needs of end users. This 'imagining' is best achieved through 'Use Cases'.

It is highly likely that the requirements/aspirations of end users will exceed the feasible deliverables, be this based on technological, financial, programme, etc. constraints. It is therefore necessary to prioritise the functional requirements.

A.1.5.4. Use Cases

Use Cases describe the application from the user's point of view, i.e. a description of the application's behaviour as it responds to a request from the user (or another application). In other words, a *Use Case* describes 'who' can do 'what' with the application in question.

Use cases, stated simply, allow description of a sequence of events that, taken together, lead to an application achieving a goal. Therefore, in defining a Use Case, the first step is to describe the goal that is to be achieved, for example, a goal may be defined as:

> *I want to be able to calculate and present (in tabular and graphical format) the Bridge Condition Indicator for the structure stock, groups of structures (using the Bridge Type Code) and individual structures, and display this for each year and over a defined range of years.*

The Use Case (or Use Cases) would then describe the full sequence of events used to produce the above, for example:

- Assumption: appropriate inventory and inspection data held by application
- Event 1: User opens BCI sub-application
- Event 2: User defines BCI evaluation period, i.e. year x1 to year x2.
- Event 3: User defines/selects levels of BCI reporting, e.g. stock, Bridge Type Code, area, route, structure etc;
- Event 4: User runs analysis;
- Event 5: User views results (in range of formats) and error reports;
- Event 6: User prints/saves reports; and
- Event 7: User selects new analysis, refines analysis or closes sub-application.

In the above scenario there are likely to be a number of variations to the Use Case. These variations would enable the scope of usage to be derived and mapped out in a Use Case Diagram. The Use Case Diagram would then form a key reference point for the developers.

In summary, a Use Case should:

- Describe what the application shall do for the end user to achieve a particular goal;
- Seek to avoid technical or implementation-specific language;
- Be at the appropriate level of detail; and
- Exclude detail regarding user interfaces and screens, this is application specific.

A.1.6. Use Cases for Asset Management Planning Toolkit

A.1.6.1. Use case Template

The table below describes the headings in the Use Case template.

Table A.1 – Use Case Template Headings

ID	Column Heading	Description
1	ID	Use case identifier/reference
2	Use Case Name	High level name given to this use case
3	Use Case Goal	A few sentences to set out the goal that is to be achieved, this will place the use case in context; if a goal cannot be defined then the use case should not exist.
4	Actors (Stakeholders)	List of those who may be interested in the outcome of this Use Case.
5	Trigger	Event that starts the Use Case.
6	Pre-conditions	Those conditions that must be in place (or true) before the Use Case can be executed.
7	Post-conditions	Set down the criteria that must be achieved for the goal to be satisfied.
8	Sequence of Events	A high level description of the sequence of events required to deliver this goal
9	MoSCoW Priority	M - MUST have this; S - SHOULD have this if at all possible; C - COULD have this if it does not affect anything else; W - WON'T have this time but WOULD like in the future.
10	Developed by	Identifies those who developed the Use Case

A.1.6.2. Use Case Goals

The workshop activity is to develop a series of Use Cases for the Asset Management Planning Toolkit; this will start with the definition of Use Case goals. The following goals are provided as a starting point for discussion:

- All relevant structure types are covered at an appropriate level of granularity;

- Provides the information required for Financial Accounting;
- Assessment of the impact of different long-term expenditure strategies on asset condition, performance, risk and maintenance shortfall.
- Assessment of the level of expenditure required to achieve a specified condition/performance over a defined time period;
- Produce suitably detailed and prioritised strengthening and improvement programmes;
- Assessment of the impact of alternative maintenance/management strategies, e.g. reactive vs. proactive (requires lifecycle planning functionality).
- Comparison of routine and capital expenditure; including the impact of one on the other;
- Assessment of the impact of alternative prioritisation criteria and weightings;
- Selected work activities are ‘fixed’ in the long-term programme.

Appendix B. Expanded List of Use Cases

Use Cases: Structures Asset Management Planning Toolkit

ID	Use Case Name	Use Case Goal	Actors (Stakeholders)	Trigger	Pre-conditions	Post-conditions	Sequence of Events	MoSCoW Priority	Use Case Developed by
1	Develop Funding Business Case	Demonstrate the investment required to manage highway structures for the next 30-year period, including all management activities (inspection, maintenance, strengthening, etc.)	Road/Highway Authority London Boroughs TfL Public/residents Businesses	New/Reviewed Investment Plan	Robust inventory data Condition data Assessment data On-going works Fixed programme of works Risk data and assessment Cost/scheme estimates and requirements Strategy, e.g. MTS, translated to bridge management	Financial profile (x time) Performance, condition, risk, asset value profiles (x time) Outcomes, i.e. structures available for use Volumes of work (x time) Assess compliance with strategy Assess value for money	i) Open Investment Planning Module ii) Define assumptions and your scenario(s), e.g. baseline, planned do minimum, time period, defined performance, defined spend etc. iii) Flag fixed works iv) Run Analysis v) View tabular and graphical outputs for condition, performance, spend, risk, asset value etc, at stock level and structure type level vi) View errors report vii) Save, delete and/or refine analysis viii) Compare to other scenarios ix) Export and/or print reports	M - Must	LoBEG AM Group
2	Develop Inspection Programme	Confirm programme of structure inspections for any upcoming period or cycle.	Road/Highway Authority	Maximise efficiencies, e.g. in Network Rail involvement, underbridge vehicle booking, etc.	Inventory data Cost estimates Strategy Budget allocation	Inspection programme Costs	i) Open Investment Planning Module ii) Define assumptions iii) Run Analysis iv) View tabular and graphical outputs v) View errors report vi) Save, delete and/or refine analysis vii) Export and/or print reports	W - Won't	SCOTS Bridges Group
3	Upload data	Easily bulk-upload data in a defined format to inform the analysis, i.e. for generating investment plans	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Robust inventory data Condition data Assessment data On-going works Fixed programme of works Risk data and assessment Cost/scheme estimates and requirements Strategy, e.g. MTS, translated to bridge management **Note:** Appropriate data fields should allow capture of construction type, structure condition inspection data, dimensions, obstacle crossed, route supported, assessed capacity and existing interim measures (desirable to have element specs.)	Data storage	i) Open Investment Planning Module ii) Upload data iii) Save data	M - Must	LoBEG AM Group
4	Review data	Review input data so that errors can be identified before the analysis is run, i.e. for generating investment plans	Road/Highway Authority London Boroughs TfL	Errors in outputs	Suitable user interface	Data storage	i) Open Investment Planning Module ii) Review uploaded data iii) Upload revised data (if necessary) iv) Save data	M - Must	LoBEG AM Group
5	Define the evaluation period	Define evaluation period, i.e. how many years will be analysed/included in the investment plan	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Strategy, e.g. MTS, translated to bridge management	Use of the defined evaluation period for generating financial plans	i) Open Investment Planning Module ii) Input required evaluation period in relevant field iii) Save input	M - Must	LoBEG AM Group
6	Define targets for structure stock	Define a 'target condition' and a target shortfall for the structure stock to inform 'what-if' analysis/scenarios when generating alternative investment plans	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Strategy, e.g. MTS, translated to bridge management Define what 'target condition' covers i.e. minimum required/preferred performance	'What-if' analysis, i.e. alternative investment plans	i) Open Investment Planning Module ii) Input targets in relevant field(s) iii) Save input(s) iv) Run Analysis	M - Must	LoBEG AM Group
7	Define 'required performance' for individual structure and/or group of structures	Define 'required performance' for individual structure and/or group of structures based on construction type and route supported, e.g. to allow flexibility for where there are Red Routes that may be required to meet higher performance targets	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Strategy, e.g. MTS, translated to bridge management	'What-if' analysis, i.e. alternative investment plans	i) Open Investment Planning Module ii) Input 'required performance' in relevant field(s) iii) Save input(s) iv) Run Analysis	S - Should	LoBEG AM Group
8	Review/amend the default engineering and maintenance data	Review/amend the default values with user-defined values in order to ensure location/authority specific costs are generated in the investment plans	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	User defined and default values that include: - Deterioration rates and service lives - Intervention condition thresholds - Intervention options - Intervention effects - Maintenance costs	Financial profile (x time) Performance, condition, risk, asset value profiles (x time) Volumes of work (x time)	i) Open Investment Planning Module ii) Amend default/values in relevant field(s) iii) Save input(s) iv) Run Analysis	M - Must	LoBEG AM Group
9	Amend the prioritisation criteria	Use of prioritisation criteria that are location/authority specific	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Agreed prioritisation criteria and algorithms	Prioritised maintenance schemes for each year in the evaluation period	i) Open Investment Planning Module ii) Amend prioritisation criteria iii) Amend prioritisation algorithms iv) Save input(s) v) Run Analysis	W - Won't	LoBEG AM Group

Use Cases: Structures Asset Management Planning Toolkit

ID	Use Case Name	Use Case Goal	Actors (Stakeholders)	Trigger	Pre-conditions	Post-conditions	Sequence of Events	MoSCoW Priority	Use Case Developed by
10	Amend the prioritisation weightings	Use of prioritisation weightings that are location/authority specific	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Agreed prioritisation weightings	Prioritised maintenance schemes for each year in the evaluation period	i) Open Investment Planning Module ii) Amend weightings iii) Save input(s) iv) Run Analysis	M - Must	LoBEG AM Group
11	Input fixed programmes of work for selected structures	Input fixed programmes of work for selected structures to override lifecycle analysis in the investment plan	Road/Highway Authority London Boroughs TfL	Authority's programme of fixed works	Agreed programme of fixed works	Investment plan takes into account fixed programmes of work	i) Open Investment Planning Module ii) Input fixed programmes of work iii) Save input(s) iv) Run Analysis	M - Must	LoBEG AM Group
12	Input fixed programmes of work for selected elements	Input fixed programmes of work for selected elements, e.g. programme for parapet/waterproofing replacement(s), to override lifecycle analysis in the investment plan	Road/Highway Authority London Boroughs TfL	Authority's programme of fixed works	Agreed programme of fixed works	Investment plan takes into account fixed programmes of work	i) Open Investment Planning Module ii) Input fixed programmes of work iii) Save input(s) iv) Run Analysis	W - Won't	LoBEG AM Group
13	Input information from lifecycle plans	Input information from individual structures' lifecycle plans to override lifecycle analysis in the investment plan	Road/Highway Authority London Boroughs TfL	Maintenance needs	At least one 'preferred' lifecycle plan exists for each structure and/or group of structures	Investment plan takes into account the 'preferred' lifecycle plan for each structure and/or group of structures	i) Open Investment Planning Module ii) Input information from individual structures' lifecycle plans iii) Save input(s) iv) Run Analysis	C - Could	LoBEG AM Group
14	Select different maintenance policies/strategies	Analyse different maintenance policies/strategies for the defined structure groups and/or individual structures; e.g. Do Nothing, Do Minimum, reactive maintenance, proactive maintenance, etc. so that alternative investment plans can be generated and compared	Road/Highway Authority London Boroughs TfL	'What-if' analysis	Rules and algorithms for different maintenance policies/strategies	'What-if' analysis, i.e. alternative investment plans	i) Open Investment Planning Module ii) Enable scenarios for different maintenance policies/strategies iii) Save input(s) iv) Run Analysis	M - Must	LoBEG AM Group
15	Analyse a wide range of structures	Analyse a wide range of highway structures types, e.g. bridges, retaining walls, culverts, masts, lighting columns, subway, tunnels, etc. so that when prioritisation of funds is considered, the available budget is allocated objectively taking into account the maintenance needs of the entire stock.	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Robust inventory data Condition data Assessment data On-going works Fixed programme of works Risk data and assessment Cost/scheme estimates and requirements Strategy, e.g. MTS, translated to bridge management	Financial profile (x time) Performance, condition, risk, asset value profiles (x time) Outcomes, i.e. structures available for use Volumes of work (x time) Assess compliance with strategy Assess value for money	i) Open Investment Planning Module ii) Define assumptions and scenario(s), e.g. baseline, planned do minimum, time period, defined performance, defined spend etc. iii) Flag fixed works iv) Run Analysis v) View tabular and graphical outputs for condition, performance, spend, risk, asset value etc, at stock level and structure type level vi) Save, delete and/or refine analysis vii) Compare to other scenarios viii) Export and/or print reports	M - Must	LoBEG AM Group
16	Include/analyse a range of maintenance work types	Include/analyse a range of maintenance work types, i.e. routine maintenance, preventive maintenance, strengthening, upgrades, etc. to ensure that all financial needs have been considered in the investment plan	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Inspection Regime Maintenance Policy and Regime Robust inventory data Condition data Assessment data On-going works Fixed programme of works Risk data and assessment Cost/scheme estimates and requirements Default values that include: - Deterioration rates and service lives - Intervention condition thresholds - Intervention options - Intervention effects - Maintenance costs	Financial profile (x time) Performance, condition, risk, asset value profiles (x time) Outcomes, i.e. structures available for use Volumes of work (x timing) Assess compliance with strategy Assess value for money	i) Open Investment Planning Module ii) Define assumptions and scenario(s), e.g. baseline, planned do minimum, time period, defined performance, defined spend etc. iii) Flag fixed works iv) Run Analysis v) View tabular and graphical outputs for condition, performance, spend, risk, asset value etc, at stock level and structure type level vi) Save, delete and/or refine analysis vii) Compare to other scenarios viii) Export and/or print reports	M - Must	LoBEG AM Group
17	Amend interventions decisions	Amend interventions decisions during the analysis at group and/or structure level to account for local factors/knowledge	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Robust inventory data Condition data Assessment data On-going works Fixed programme of works Risk data and assessment Cost/scheme estimates and requirements Strategy, e.g. MTS, translated to bridge management	Financial profile (x time) Performance, condition, risk, asset value profiles (x time) Outcomes, i.e. structures available for use Volumes of work (x time) Assess compliance with strategy Assess value for money	i) Open Investment Planning Module ii) Define assumptions and scenario(s), e.g. baseline, planned do minimum, time period, defined performance, defined spend etc. iii) Flag fixed works iv) Run Analysis v) View tabular and graphical outputs for condition, performance, spend, risk, asset value etc, at stock level and structure type level vi) Amend/change timing of interventions vii) Save, delete and/or refine analysis viii) Compare to other scenarios ix) Export and/or print reports	M - Must	LoBEG AM Group

Use Cases: Structures Asset Management Planning Toolkit

ID	Use Case Name	Use Case Goal	Actors (Stakeholders)	Trigger	Pre-conditions	Post-conditions	Sequence of Events	MoSCoW Priority	Use Case Developed by
18	Group maintenance interventions	Logically group maintenance interventions into schemes	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Rules and algorithms for grouping interventions into schemes	Identified maintenance schemes for each year in the evaluation period	i) Open Investment Planning Module ii) Define assumptions and scenario(s), e.g. baseline, planned do minimum, time period, defined performance, defined spend etc. iii) Flag fixed works iv) Run Analysis v) View tabular and graphical outputs for condition, performance, spend, risk, asset value etc, at stock level and structure type level vi) Save, delete and/or refine analysis vii) Compare to other scenarios viii) Export and/or print reports	W - Won't	LoBEG AM Group
19	Calculate depreciation replacement cost (DRC)	Calculate DRC in accordance with accepted financial reporting requirements	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Rules and algorithms for calculating depreciation	Financial profile (x time) Performance, condition, risk, asset value profiles (x time) Outcomes, i.e. structures available for use Volumes of work (x time)	i) Open Investment Planning Module ii) Define assumptions and scenario(s), e.g. baseline, planned do minimum, time period, defined performance, defined spend etc. iii) Flag fixed works iv) Run Analysis v) View tabular and graphical outputs for condition, performance, spend, risk, asset value etc, at stock level and structure type level vi) Save, delete and/or refine analysis vii) Compare to other scenarios viii) Export and/or print reports	M - Must	LoBEG AM Group
20	Run analysis with and without routine maintenance	Run analysis with and without routine maintenance	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Functionality and algorithms for including/excluding	Financial profile (x time) Performance, condition, risk, asset value profiles (x time) Outcomes, i.e. structures available for use Volumes of work (x time)	i) Open Investment Planning Module ii) Enable/disable function for the inclusion of Routine Maintenance scenarios for different maintenance policies/strategies iii) Save input(s) iv) Run Analysis	M - Must	LoBEG AM Group
21	Present statistics	Present a wide range of statistics (tabular and graphical) per year for the whole analysis period for: - Bridge Condition Indicator at stock, group and structure level - Maintenance expenditure profiles: at stock, type/group, structure level; by element type and intervention type, i.e. Revenue vs. Capital - Maintenance shortfall: at stock, type/group, structure level; by element type and intervention type, i.e. Revenue vs. Capital - Consequences (substandard, traffic delay, closures, interim measures etc.) at stock, type/group, structure level	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Analysis has been run	Analysis has been saved	i) Open Investment Planning Module ii) View output(s)	M - Must	LoBEG AM Group
22	Save the outputs	Save the outputs of each run so that they can be compared with other runs	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Define the most important things to compare Analysis has been run	Analysis has been saved	i) Open Investment Planning Module ii) Run analysis iii) Interrogate output(s) iv) Save analysis output(s)	M - Must	LoBEG AM Group
23	Present asset valuation and depreciation outputs	Provide asset valuation and depreciation outputs as required by finance	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Confirm breakdown required Analysis has been run	Analysis has been saved	i) Open Investment Planning Module ii) View output(s)	M - Must	LoBEG AM Group
24	View maintenance strategies	View maintenance strategies (i.e. intervention times and selected treatment) at structure level	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Analysis has been run	Analysis has been saved	i) Open Investment Planning Module ii) View output(s)	M - Must	LoBEG AM Group
25	Output of fixed programmes of works	Output of fixed programmes of works including changes made	Road/Highway Authority London Boroughs TfL	New/Reviewed Investment Plan	Analysis has been run	Analysis has been saved	i) Open Investment Planning Module ii) View output(s)	M - Must	LoBEG AM Group

Appendix C. Use Case Diagrams Basics

C.1. Use Case Diagram

A use case diagram (UCD) in the Unified Modelling Language (UML) is used to present a graphical overview of the functionality provided by a system. That is, rather than representing the details of the individual features of a system, UCDs can be used to show all of its available functionality from a top-down perspective (that is, at a glance the system's functionality is obvious, but all descriptions are at a very high level. It is important to note, though, that UCDs are fundamentally different from sequence diagrams or flow charts because they do not make any attempt to represent the order or number of times that the system's actions and sub-actions should be executed.

C.1.1. Diagram Building Blocks

UCDs have 4 major elements: The ***actors*** that the described system interacts with, the ***system*** itself, the ***use cases*** (or services) that the system knows how to perform, and the lines that represent ***associations*** between these elements.

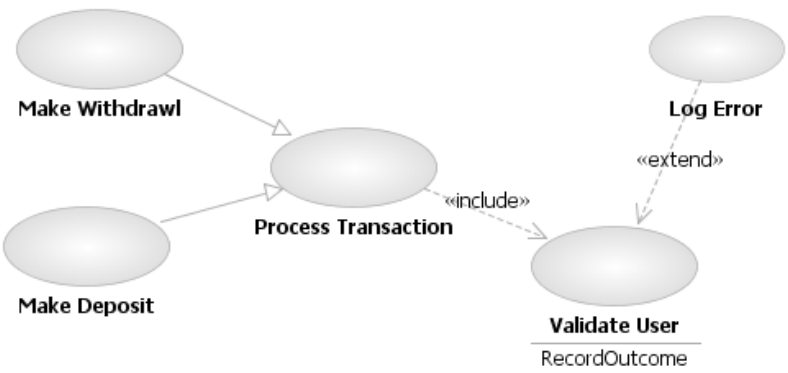
- ***Use cases*** – A use case describes a sequence of actions that provide something of measurable value to an actor and is drawn as a horizontal ellipse.
- ***Actors*** – Actors represent the roles that can be played by the users of the system. An actor is a person, organization, or external system (hardware/software) that plays a role in one or more interactions with the described system. Actors are drawn as stick figures.
- ***Associations*** – Associations between actors and use cases are indicated in UCDs by solid lines. An association exists whenever an actor is involved with an interaction described by a use case. Associations are modelled as lines connecting use cases and actors to one another, with an optional arrowhead on one end of the line. The arrowhead is often used to indicate the direction of the initial invocation of the relationship or to indicate the primary actor within the use case. However, the arrowheads should not be confused with data flow.
- ***System boundary box*** – A rectangle can be drawn around the use cases, called the system boundary box, to indicate the scope of the system. Anything within the box represents functionality that is in scope and anything outside the box is not.
- ***Packages*** – Packages are used to facilitate the organisation of model elements (such as use cases) into groups. Packages are depicted as file folders.

C.1.2. Use Case Relationships

Three relationships exist amongst use cases:

- ***Include*** – In one form of interaction, a given use case may include another. 'Include' is a directed relationship between two use cases, implying that the behaviour of the included use case is inserted into the behaviour of the including use case.

  The first use case often depends on the outcome of the included use case. This is useful for extracting truly common behaviours from multiple use cases into a single description. The notation is a dashed arrow from the including to the included use case, with the label '«include»'. This usage resembles a macro expansion where the included use case behaviour is placed inline in the base use case behaviour. There are no



parameters or return values. To specify the location in a flow of events in which the base use case includes the behaviour of another, you simply write include followed by the name of use case you want to include, as in the above diagram for tracking an order.

- ***Extend*** – In another form of interaction, a given use case (the extension) may extend another. This relationship indicates that the behaviour of the extension use case may be inserted in the extended use case under some conditions. The notation is a dashed arrow from the extension to the extended use case, with the label '«extend»'. Notes or constraints may be associated with this relationship to illustrate the conditions under which this behaviour will be executed. Modellers use the «extend» relationship to indicate use cases that are 'optional' to the base use case. Depending on the modeller's approach 'optional' may mean 'potentially not executed with the base use case' or it may mean 'not required to achieve the base use case goal'.
- ***Generalisation*** - In the third form of interaction among use cases, a generalisation/specialisation relationship exists. A given use case may be a specialised form of an existing use case. The notation is a solid line ending in a hollow triangle drawn from the specialized to the more general use case.