

I AM BECAUSE WE ARE  
A SYSTEMS APPROACH TO STRATEGY DESIGN

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BY

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# ABSTRACT

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The word *strategy* has represented many concepts since it originated in the military domain. Fundamentally, it is concerned with determining how best to direct systems in a changing world. In the military context, strategic decisions are made by a commander and communicated through a hierarchical chain of command. However, in today's increasingly complex and vertically separated sectors, conventional top-down approaches to strategy design are becoming less applicable. The South African proverb *I am because you are* encapsulates the idea that the world is not formed of independent, separate entities, but that all beings and actions are connected. In this thesis, I put forward a case for applying this way of thinking in a systems approach to designing strategy.

The approach was developed using the Seven Views process modelling framework, informed by a comprehensive literature review and an evaluation of existing strategy documents. I define and describe three consecutive processes for designing strategy which are aligned with the systems engineering principles identified in the research. The Plan and Capture processes produce the information that constitutes a strategy, while the Communicate process encapsulates and disseminates a view of that information to a particular audience. A case study is carried out to show how the approach could be practically applied. I argue that strategy documents produced by following the approach would be clearer and more rigorous.

To the field of strategy, my research offers a new approach to strategy design, a language framework for discussing strategy concepts, and pragmatic guidance for designing strategy. In the field of systems thinking, it contributes to the challenge of translating and demystifying systems engineering practices for non-traditional domains.

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# GLOSSARY AND ABBREVIATIONS

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Approach	A way of doing something which includes one or more processes.
Case Study	A particular instance of something used or analysed in order to illustrate a thesis or principle. (Oxford Dictionaries, 2015)
Communication	A process whereby people in groups, using the tools provided by their culture, create collective representations of reality. (Trenholm, 1999)
Complex	A system comprising many different and connected parts, whose outcomes are not easy to understand or predict.
Complicated	A system comprising many different parts, whose outcomes can be managed and predicted to a certain extent.
Context	A description of how decisions and actions for one system can affect other systems or the wider environment.
Guidance	Advice aimed at directing an individual to carry out a particular activity or process.
Language	A tool for communication.
Lifecycle	The whole life of something, from conception to retirement.
Model	The outcome of a modelling exercise.
Modelling	The simplification of reality intended to promote understanding. (Bellinger, 2004)
Policy	The description of an issue that is currently supported by an organisation.
Process	A way of doing something that comprises a number of activities which produce or consume information and are the responsibility of a stakeholder. (Adapted from Holt, 2005)
Purpose	The reason for which something is done or created or for which something exists. (Oxford Dictionaries, 2015)
Requirement	A description of what is needed from a system or process, including the expectations of relevant stakeholders.
Scope	A description of the boundaries of a system, including what is and is not included.
Stakeholder	A person or entity that has an interest in the system.
System	An integrated set of elements that accomplish a defined objective. (INCOSE, 2000)
Systems Engineering	An interdisciplinary approach and means to enable the realisation of successful systems. (INCOSE, 2004)

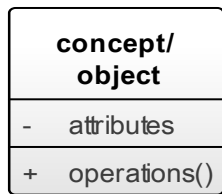
System of Systems	Large-scale integrated systems which are heterogeneous and independently operable on their own, but are networked for a common goal. (Jamshidi, 2008)
Strategy	The description of <i>where</i> an organisation or system is envisioned to be by a defined future point, <i>how</i> it plans to get there, and <i>what</i> activities will be carried out to achieve this.  Refer to more detailed interpretations of <i>strategy</i> in Chapter 2.
Traceability	The explicit linking of key information to its source and to any related information.
Validation	The determination of whether the output of a process satisfies the original need.
Verification	The determination of whether a process has been carried out correctly.
Vertically integrated	A system whose supply chain is owned or managed by the same body.

EU WP	European Union White Paper for Transport
HLOS	High Level Output Specification
NHS	National Health Service
NR	Network Rail
ORR	Office of Rail and Road
RSSB	Rail Safety and Standards Board
RSSSG	Rolling Stock Strategy Steering Group
RTS	Rail Technical Strategy
SE	Systems Engineering
SoFA	Statement of Funds Available
SoS	System of Systems
TfL	Transport for London
TSI	Technical Specification for Interoperability

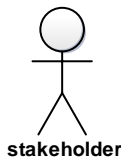
# UML NOTATION

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## PRINCIPAL ELEMENTS



A rectangular or square box is called a *class* in the UML class diagram. This symbol can be used to represent concepts, such as information and processes, or objects, such as stakeholders or components. Further detail about the concept or object can be included in drop-down boxes underneath the class, which describe its features (attributes) and behaviours (operations).



A 'stick man' symbol is called an *actor* in the UML use case diagram. It is used to show a stakeholder that has an interest in a particular requirement, either as the customer or the responsible party. The symbol can represent organisations and objects, as well as people.



An ellipse shape, or *use case*, is used in the UML use case diagram to illustrate a requirement. It is usually connected to a stakeholder.



A rounded box represents an activity in the UML activity diagram. Relationship arrows between activities shows the order of activities in a process.

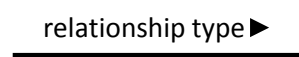
## RELATIONSHIPS



A line with a triangular tip shows the relationship 'is a type of'. In the example, the symbol shows that a dog is a type of animal.



A line with a diamond-shaped tip shows the relationship 'is made up of'. In the example, the symbol shows that a dog is made up of a body (among other parts).

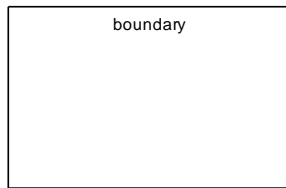


A line with a label and arrowhead shows the type of relationship and the direction. For example, dog chases ball.



A dotted arrow shows a dependency between two elements. In a use case diagram, this symbol is used to illustrate constraints and requirements detail. In an activity diagram, it shows the order of activities and information flow.

## GENERAL SYMBOLS



A box around a group of elements indicates the boundary of a system or concept. This symbol is used in use case diagrams to show the interface between requirements and stakeholders.

1...\*  
2  
0...1

Numerical figures indicate the number of instances of the related concept or object. A single number shows the exact number, 1...\* means that there are between 1 and many instances, and 0...1 represents 0 to 1 instances. For example, to show that a dog is made up of 4 legs, the number 4 would be shown on the relationship at the end of the 'leg' class.



A solid black circle in the UML activity diagram indicates the start of the process.



A 'polo' shaped circle in the UML activity diagram indicates the end of the process.

<<description>>

Text in parenthesis serves to describe a concept, object or relationship. In the use case diagram, this is used to show the *constrain* or *include* relationship. In the class diagram, it describes the type of concept or object.

*'A leader's powers of analysis and decision-making are of no use if he cannot communicate his intentions clearly.'*

(British Army, 2010, p. 2:30)

# CHAPTER 1

## INTRODUCTION

---

### 1 Background

The word *strategy* is fundamentally concerned with how best to direct an entity in a changing world (Moore, 1992). As the world evolves, so too must the strategies of organisations and systems that exist within it. Strategy originated in a military context, with leaders such as Frederick the Great first looking beyond individual battles to gain victory in whole wars (Clausewitz, 1832). In this early model, strategic decisions were made at the highest level and communicated down through a hierarchical chain of command. Corporate strategy followed the military example, being decided at the top and focussing on the success of individual organisations in a competitive environment.

Today, however, strategy extends beyond the isolated success of vertically integrated organisations. Increasingly, the connectivity between previously independent systems is being harnessed to create complex<sup>a</sup>, multi-stakeholder *systems of systems*<sup>b</sup>. Power grids, communications networks, smart cities, healthcare, water management, and transportation systems are such examples, each involving many decision makers and requiring careful strategic direction. These sectors frequently integrate public and private bodies, pursuing common objectives while maintaining their individual purpose.

The South African proverb ‘I am because you are’ suggests that humanity is not made up of separated individuals, but that our actions are connected and affect the whole World (Tutu,

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<sup>a</sup> The term complex is used in this thesis to describe a system ‘in which there are multiple interactions between many different components’ (Rind, 1999, p. 105) and which is ‘difficult to understand and verify’ (Gezhi Weng, 1999, p. 92). This concept will be further discussed in Chapter 4.

<sup>b</sup> The term system of systems has specific connotations in the systems engineering domain. For the purpose of this work, I am adopting the definition by Jamshidi (2008, p. 44): ‘systems of systems are large-scale integrated systems which are heterogeneous and independently operable on their own, but are networked for a common goal.’

2008). Likewise, in a system of systems, every action has a possible consequence on other systems and on the wider environment. Designing strategies for these systems, therefore, requires a systems approach. Systems thinking has long been valued in the making of strategic decisions. General Systems Theory influenced early developments in the field of strategy, which evolved from adopting an inward-facing to an outward-facing perspective. Systems thinking principles, such as considering the whole problem, determining objectives, and understanding context contributed to the development of influential strategic decisions making tools, including Systems Analysis (Quade, 1969).

Strategic decisions are commonly disseminated in formal documents. Publications such as *Everyone Counts: Planning for Patients* (NHS England, 2013), *Roadmap to a Single European Transport Area* (European Commission, 2011a), and *Future Water* (Defra, 2011) set out the strategies of complex, multi-stakeholder systems. Within those systems, further strategy documents communicate the objectives of individual organisations or subsystems, such as NHS Trusts (St George's Healthcare NHS Trust, 2012), railway industries (TSLG, 2012), and water companies (Severn Trent Water, 2007). However, there is no standard approach to creating such documents, which are often the responsibility of different stakeholders across the system of systems. Consequently, the structure and content of strategy documents is often inconsistent and there can be a limited understanding of the whole picture. Despite the presence of systems thinking in strategic decision making, it appears to be lacking in the ultimate communication of those decisions.

Research shows that there is a correlation between the effective communication of strategic decisions and the perceived success of the strategy (Johnson, 2002) (Shepherd, 2010). There is even evidence to suggest that the effective communication of *poor* strategic decisions can still lead to ultimate success for the organisation or system (Lee & Puranam, 2013). In the work which follows, I propose a systems approach to planning, capturing and communicating strategy, based on principles from the systems engineering (SE) domain. The approach



considers all the activities required to design a strategy, not solely the decision making processes, as is the focus of much existing literature.

## 2 Scope

Scholars have researched, analysed and documented the vast and multi-dimensional field of strategy for many years. In this thesis, I specifically examine the processes of planning, capturing, and communicating strategy, which I name *strategy design*. In the following section, I will set out the boundaries of this research project by stating which aspects are included in the scope of study and those which are excluded.

### 2.1 Strategy

#### 2.1.1 Domains

I consider strategy design to be a universal challenge which exists in every domain. Therefore, the approach presented in this thesis is directed at any type of organisation within any sector. The British railway system is used as an example to support my argument for the adoption of a systems approach to designing strategy, especially for complex, multi-stakeholder sectors. Testing of the approach in other domains is not included in the scope of this research, but is recommended for further work.

#### 2.1.2 Hierarchy

Strategy design exercises are carried out across all hierarchical levels in an organisation – from designing high level business strategies to detailed technical and operational strategies. The approach presented in this thesis has been designed to be applicable at any level of hierarchy. The activities in the approach are generic and the guidance provides examples for different levels of complexity and practical applications.

#### 2.1.3 New and Existing

I recognise that strategy design rarely begins with a blank canvas; there is often an existing version of the strategy which must be replaced or updated. Therefore, the approach presented

in this work is intended to be suitable both for designing new strategies and for renewing and updating those which already exist.

#### 2.1.4 Context and Perspective

The motivations for designing a particular strategy depend greatly on the context and the perspectives of those involved. There may be implicit or indirect reasons for the exercise, such as the need to influence others, the result of political pressure, or the desire to be innovative. It is also entirely possible that a single strategy serves as a tool for different purposes to different stakeholders. In such scenarios, the language to communicate the strategy may be intentionally vague and ambiguous in order to influence, hide intentions, or allow scope for later adaptation.

Much of the existing literature addresses these complex, socio-political aspects of the field of strategy. My research, by contrast, approaches the subject from an engineering perspective, where strategies are considered as the drivers of projects and initiatives which shape the world. Although there may be many implicit reasons for designing a strategy, they are not considered in this work. Instead, I assume that the purpose of a strategy design exercise is to determine the most appropriate future direction for an organisation and to communicate this effectively to those responsible for its delivery.

#### 2.1.5 Emergent Strategy

A notable characteristic of systems of systems, which are 'heterogeneous and independently operable on their own, but are networked for a common goal' (Jamshidi, 2008, p. 44), is the emergence of unplanned or unforeseen behaviours. In these situations, strategies have been known to emerge spontaneously without deliberate planning. My research, however, is only applicable to strategies that are consciously initiated, and does not apply to these emergent strategies.

## 2.2 Lifecycle Processes

The research presented in this thesis includes the definition of the problem (that current strategy design approaches are insufficient for complex systems of systems) and the design of a solution (a formalised, systems approach to strategy design). It includes verification that the approach has been developed correctly, but it does not include validation of the proposed solution.

## 3 Context

### 3.1 The Railway Industry

Britain's railway is a complex, multi-stakeholder system comprising public, private and third sector bodies. The overall strategy set out by government is delivered by public and private organisations, which also pursue their own strategic direction. As part of the wider European transport system, Britain's railways are also subject to European level strategic decisions expressed in regulations. Many different strategies have been produced to address the challenges and to identify the opportunities which are presented to the industry today. However, as I will demonstrate, there is a lack of systems thinking in designing such strategies.

In 2011, an independent report highlighted Britain's recent poor record of implementing solutions presented in strategy documents (McNulty, 2011, p. 41). The report concluded that 'Government and industry processes for setting objectives and strategies should be reformed to give a clearer line of sight between high level policies and the delivery outputs on the ground' (p. 43). It was proposed that policies, objectives, strategies and implementation be better aligned in order to clarify what the industry intends to deliver.

### 3.2 Systems Thinking

Systems thinking is commonly described as the idea that a whole is greater than the sum of its parts. It includes understanding the complete picture and recognising interdependencies between seemingly unrelated entities. My research addresses recent calls for a more whole system view of Britain's railways (McNulty, 2011) (Department for Transport, 2012a) (TSLG,

2012), by aligning strategy design with systems engineering principles. The research also supports the target of the International Council on Systems Engineering to advance systems engineering concepts to non-traditional domains, including leadership (INCOSE, 2012).

### 3.3 Previous Work

In 2011, academics at the University of Birmingham undertook a collaborative project to identify requirements statements in railway strategy documents (Mason, et al., 2012). The study viewed these documents as a means for communicating decisions to those responsible for their delivery. In the published paper, the authors address the problem that manually recognising requirements statements in these lengthy documents is a time consuming and subjective process (p. 1). As an alternative, Mason et al. propose a computer programme which can automatically detect the linguistic patterns of requirements in dense text.

In the exercise, a set of requirements are positively identified in a European Union (EU) transport White Paper (European Commission, 2011a). However, the authors describe the elicitation of requirements to be a 'black art' (p. 2), where opinion differs as to whether a certain phrase is or is not a requirement. In industry, requirements are expected to be communicated in a consistent linguistic structure, often using 'shall' and 'should' statements (NASA, 2014) (Alexander & Stevens, 2002) (BSi, 2002). Mason et al., however, identify ten different linguistic patterns in the requirements expressed in the document. Although the computer programme is capable of producing a list of requirements, it does not capture rationale or background knowledge, which is important information for managing requirements.

The research by Mason et al. demonstrates the potential benefits of developing an automated requirements capture system. However, it also highlights the difficulties faced in identifying requirements in certain strategy documents. Reviewing the work led me to reason that in order to improve the process of identifying requirements in strategy documents, the quality of the

documents themselves should be improved. This idea subsequently became the premise of this research project, which began with an evaluation of the EU transport White Paper.

## 4 Research Objectives

The purpose of this research project is to propose a formalised, systems approach to strategy design for complex, multi-stakeholder sectors. Underpinning the project are the following research questions:

1. What does *strategy* mean?
2. What is strategy design?
3. Why are current approaches to strategy design insufficient?
4. What challenges do complex sectors face in designing strategy?
5. How can systems thinking help to address these challenges?

Answers to these five research questions will be sought through a literature review, an evaluation of current practices, and the design of a proposed approach to strategy design.

## 5 Approach

The research project has been managed as a design exercise, where the required deliverable is the development of an approach for designing strategy. A systems engineering approach was adopted in the planning of the work, as demonstrated in Figure 1.

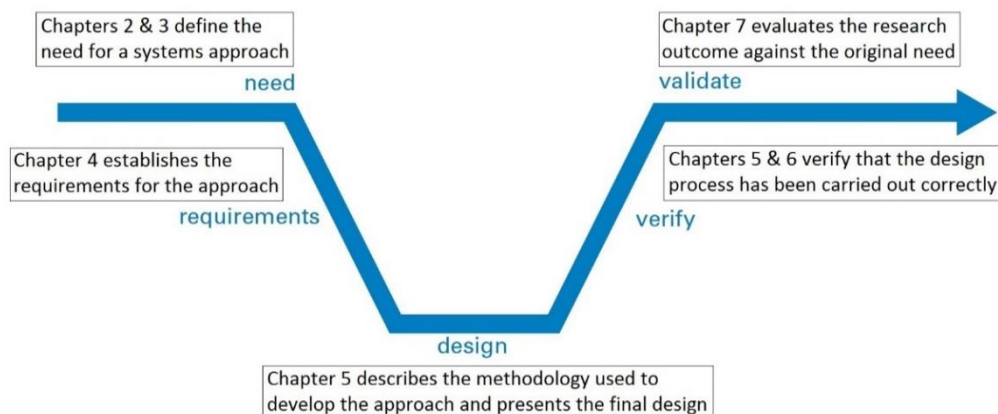


Figure 1 - V lifecycle model adapted from (INCOSE UK, 2009)

The problem and need addressed by the exercise are examined in Chapters 2 and 3, through a review of relevant literature and the British railway system example. The requirements for the approach are identified during this preliminary work and the evaluation in Chapter 4. Where a particular section of the thesis leads to a requirement, this is shown through the use of a footnote (for example, pg. 18), and the requirements are amalgamated in Chapter 4. In Chapter 5, I present the proposed approach through the Unified Modelling Language (OMG, 2015b) and using the Seven Views process modelling framework (Holt, 2005). The approach is verified in Chapters 5 and 6 through consistency checks and application of the processes in a case study. Finally, in Chapter 7, the research outcomes are evaluated against the original need.

## 6 Thesis Structure

An overview of each of the thesis chapters is given below.

### **1. Introduction**

In Chapter 1, I describe the background to the research problem and introduce the proposed approach to a solution. The research objectives, context and scope of the project are established.

### **2. Literature Review**

In Chapter 2, I conduct a comprehensive review of literature related to the fields of communication, strategy and systems thinking. Key words and concepts are defined and existing approaches to strategy design are explored.

### **3. The British Railway Example**

In Chapter 3, I describe the research problem in the specific context of the British railway industry. The structure of the industry and the decision making processes are examined, and four influential strategy documents are presented.

#### **4. Strategy Documents Evaluation**

In Chapter 4, I present the results of two evaluations of existing strategy documents. The first considers how well each document is aligned with systems engineering principles and the second is a user evaluation. The requirements identified in Chapters 2, 3 and 4 are amalgamated.

#### **5. A Model for Strategy Design**

In Chapter 5, I explain the choice of methodology and modelling language used to develop the strategy design approach. The approach is then presented through the seven views specified in the methodology

#### **6. Applying the Strategy Design Approach**

In Chapter 6, I describe each activity of the strategy design processes and demonstrate how they might be applied in an example case study. The draft strategy document produced during the case study is evaluated against the systems engineering principles.

#### **7. Conclusions**

In Chapter 7, I review the proposed strategy design approach against the original requirements established in Chapter 4. Conclusions are drawn and areas for future research are suggested. Further work is recommended to refine and validate the approach.

#### **Appendix**

The Appendix contains the strategy design Guidance and Case Study documents, which are the principal outputs of my work. The guidance is intended to serve as a standalone document for anyone carrying out a strategy design exercise. It includes descriptions of each activity in the approach, examples and further references. The case study demonstrates an example of how the approach could be used to design a strategy for an example scenario. The Appendix also contains the detailed responses from the user survey and stakeholder interviews.

## 7 Publications

### 7.1 Contributing Work

The following publications present preliminary work carried out during the course of this research project.

- EVANS, R. & ROBERTS, C., 2013. *ON THE RIGHT TRACK: A CASE FOR APPLYING SYSTEMS ENGINEERING TO WRITING TRANSPORT POLICY DOCUMENTS*. PHILADELPHIA, PROCEEDINGS OF THE INCOSE INTERNATIONAL SYMPOSIUM.

This paper presents an initial analysis of the European White Paper for Transport (European Commission, 2011a) by evaluating requirements identified in the document against systems engineering best practice. The work led to the selection of this document in the user evaluation set out in Chapter 4.

- EVANS, R., BROWNSWORD, M. & ROBERTS, C., 2013. *WRITING BETTER RAILWAY POLICY: A MORE EFFICIENT APPROACH TO EXPRESSING REQUIREMENTS IN RAILWAY POLICY DOCUMENTS*. SYDNEY, PROCEEDINGS OF THE WORLD CONGRESS ON RAILWAY RESEARCH.

In this paper, we propose a model based approach to expressing requirements in policy documents. The work forms part of the recommendations in the strategy design guidance in the Appendix.

### 7.2 Related Work

The following publications were not direct inputs to this research project. However, they were influential in guiding the approach which I adopted in carrying out the work.

- COWPER, D., KEMP, D., ELPHICK, J. & EVANS, R., 2014. *TO V OR NOT TO V – THAT MUST BE THE QUESTION: KNOWING WHEN TO APPLY THE RIGHT APPROACH*. HENDERSON, NV, PROCEEDINGS OF THE 2014 INCOSE INTERNATIONAL SYMPOSIUM.



This paper presents the results of a study into the gap between the SE required and the SE delivered through the use of Snowden's Cynefin framework. This work was influential in determining the appropriate level of SE to apply to the field of strategy.

- KEMP, D., CAMM, D., EVANS, R. & ELPHICK, J., 2013. *STEAMPUNK SYSTEM OF SYSTEMS ENGINEERING: A CASE STUDY OF SUCCESSFUL SYSTEM OF SYSTEMS ENGINEERING IN 19TH CENTURY BRITAIN*. PHILADELPHIA, PROCEEDINGS OF THE INCOSE INTERNATIONAL SYMPOSIUM 2013.

In this paper, we describe the transformation of the British railway industry from individual systems, through a single stated-owned system, to a system of systems. This work contributed to my understanding of the complication and complexity of the British railway system today.

- SILMON, J., NICHOLSON, D., EVANS, R. & BROWNSWORD, M., 2015. *AN ARCHITECTURAL APPROACH TO REQUIREMENTS ENGINEERING FOR INFRASTRUCTURE PROJECTS*. SYSTEMS ENGINEERING, 18(3), PP. 300-309.

This paper presents the model based requirements management approach adopted by Atkins on the HS2 high speed railway project. Participating in this work influenced my vision for a model based approach to strategy design, as described in Chapter 5 and the Appendix.

### 7.3 Pending

- EVANS, R., ROBERTS, C. & ELPHICK, J., 2016. *JOINING THE DOTS: THE CASE FOR A SYSTEMS APPROACH TO STRATEGY DESIGN FOR VERTICALLY SEPARATED TRANSPORT SYSTEMS*. SHANGAI, 14TH WORLD CONFERENCE ON TRANSPORT RESEARCH – ACCEPTED FOR FULL PAPER PRESENTATION.

In this paper, the work presented in Chapters 2 and 3 of this thesis forms a case for adopting a systems approach to designing strategy.

# CHAPTER 2

## LITERATURE REVIEW

---

### 1 Introduction

The work presented in this thesis addresses the significant and well-researched fields of strategy and systems thinking. In the following chapter, I discuss literature in each of these areas relating to the research questions established in the Introduction. The purpose of this literature review is to set the context of my research and to demonstrate the need for further exploration where the domains intersect. First, however, I begin by discussing the question of communication, which is crucial to the fields of both strategy and systems thinking, and is a central theme in this work.

### 2 Communication and Language

At the heart of the work presented in this thesis is the notion of communication. Specifically, I address the challenge of communicating strategic decisions to those who will deliver them. Derived from Latin roots, the word *communication* literally means *to share*. Fiske (1990, p. 2) extends this early description of the concept to define communication simply as 'social interaction through messages'. Trenholm (1999, p. 31) expands this understanding further by describing communication as 'a process whereby people in groups, using the tools provided by their culture, create collective representations of reality'. This definition suggests that there is more to communication than simply the transfer of information from one person to another. It is in fact a collaborative process, aimed at developing a shared understanding of a particular reality. Thompson (2011) explains why communication is not simply the 'mechanical process' of passing on information:

*When I communicate with you, then there is the question of what I intend (that is, my meaning). There is also the question of how you interpret my communication to you. Your response will then depend on what you mean/intend and how I interpret that response (p. 15).*

Information might be passed from one person to another, but if the meaning is not interpreted in the way which was intended, the communication is not effective. If strategic decisions are not effectively communicated, there is a risk that the strategy will be poorly delivered (Johnson, 2002) (Shepherd, 2010). The communication tools described by Trenholm are commonly known as *languages*. They include natural (human) languages, body language, graphical languages, computer programming languages, and so forth. Languages effectively allow perceptions of reality to be coded for others to share understanding. Strategic decisions are normally communicated through the use of natural language – that is the language which is adapted to man’s psychological nature (Lyons, 1991, p. 2). Language is ‘one of the most complex and unique of human activities’ (Winograd, 1972). As such, it can be both a communication tool and a barrier (Kovačević, 1995) (Sayer, 2013). The inherent ambiguity of natural language was the subject of fundamental work by celebrated linguist, Ferdinand de Saussure (1916).

## 2.1 The Linguistic Sign

De Saussure was one of the first major thinkers in the study of (natural) language (Thomas, 2011, p. xv). His founding principle, the Linguistic Sign, presents a two-sided model of language comprising a *sound-image* and a *concept* connected by an *associative bond* (de Saussure, 1916, p. 66). The sound-image is the psychological imprint that a sound makes on our senses, and the concept is the mental fact that the sound-image evokes. In de Saussure’s example (Figure 2) the Latin sound-image *arbor* evokes the concept of the word *tree* or the mental impression of a tree. De Saussure understood language to be the communication of a concept from one individual to another through corresponding sound-images (p. 11). His idea challenged the traditional perception of language as a ‘list of words, each corresponding to the thing that it names’ (p. 66).

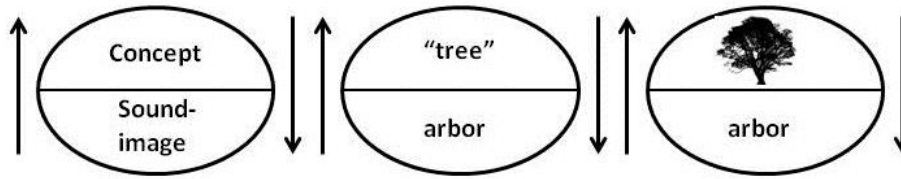


Figure 2 - Example of the Linguistic Sign (adapted from de Saussure, 1916)

De Saussure (1916, p. 67) believed that the relationship between a sound-image and a concept is arbitrary; in other words, there is no reason why one sound-image should signify a particular concept. In fact, the meaning of any given sound-image is dependent on the context and the experience of the person interpreting it in that moment. For example, the word *toll* might initially evoke a number of different concepts depending on the perspective of the recipient. It could call to mind a *toll road*, a *death toll*, the *toll of a bell*, or something else altogether. To a German speaker, it would probably signify a different concept, meaning *incredible* or *amazing*. The study of meaning, today known as Semantics, demonstrates the challenges associated with communicating effectively.

## 2.2 Relationships

Relationships are central to the concepts of language and communication. They exist between the sound-image and the concept, among words in an act of communication, and in the concepts which are evoked. The South African humanist philosophy Ubuntu, whose proverb is incorporated in the title of this thesis, emphasises the importance of relationships between human beings. It suggests that ‘a person is a person through other persons’ – in other words, we are not individuals that are separated from one another, but our connected actions affect ‘the whole World’ (Tutu, 2008). In essence, we are only identified and validated as people through our *relationships* with other people, and without these relationships, we do not ‘exist’. I believe that the Ubuntu philosophy can equally be applied to language and communication. Human relationships are formed through languages, and the human mind is an essential part of the linguistic sign (without a recipient, language does not ‘exist’). A word only has meaning

through its association and relationships with others, and a word in isolation is generally insufficient. In my earlier example, the word *toll* only begins to have true meaning once it is associated with other words, such as *road* or *bell*.

A dictionary relies upon and exploits these relationships between words to provide definitions. The purpose of a definition is to explain what a word means (Bickenbach & Davies, 1996). However, traditional dictionary definitions are constrained by the aforementioned limitations and intricacies of natural language. The challenge is to use *different* words to evoke the same concept inferred by the defined word. Sometimes, however, definitions fail to achieve this. For example, one definition of the word *language* reads: ‘any one of the systems of human *language* that are used and understood by a particular group of people’ (Merriam-Webster, 2015, author’s italics).

In other cases, a definition provided for one word may require the reading of another, then another and so forth. For example, an alternative definition of *language* is ‘the method of human communication, either spoken or written, consisting of the use of words in a structured and conventional way’ (Oxford Dictionaries, 2015). However, this definition is only useful if the dictionary user already understands the concept that is implied by the term *communication*. Likewise, the definition of *communication* as ‘the imparting or exchanging of information by speaking, writing, or using some other medium’ (Oxford Dictionaries, 2015) presumes the correct understanding of the word *information*. As in the Ubuntu philosophy, each word only has meaning once used in relation to another. Dictionary definitions are useful for grasping the general meaning associated with a particular word, but they should also be approached with caution. Although human language has enabled many of man’s achievements, it is sometimes an inadequate tool for expressing the complex concepts of the human mind.

## 2.3 Modelling

Another way to communicate complex concepts is through the use of modelling. The activity is not intended to replace natural language but to be complementary, thereby improving clarity and reducing misinterpretation. Modelling illustrates the connectedness of information, whereas text and speech are linear in nature and emphasis only one ‘order of connection’ (The Open University, 2011). Modelling can be considered as ‘a simplification of reality intended to promote understanding’ (Bellinger, 2004). System modelling, process modelling, geometric modelling, mathematical modelling, scale modelling, and so forth are commonly used means of simplifying a particular reality in order to better understand an aspect of it. The notion that an entity is defined by its relationships is particularly pertinent in the modelling domain, where systems and concepts are defined and understood through their relationships with others. The output of a modelling exercise is often a diagram, or series of diagrams, showing the relationships between words, information, or concepts. Figure 3 shows a modelled version of the earlier dictionary definitions using the Unified Modelling Language (OMG, 2015b).

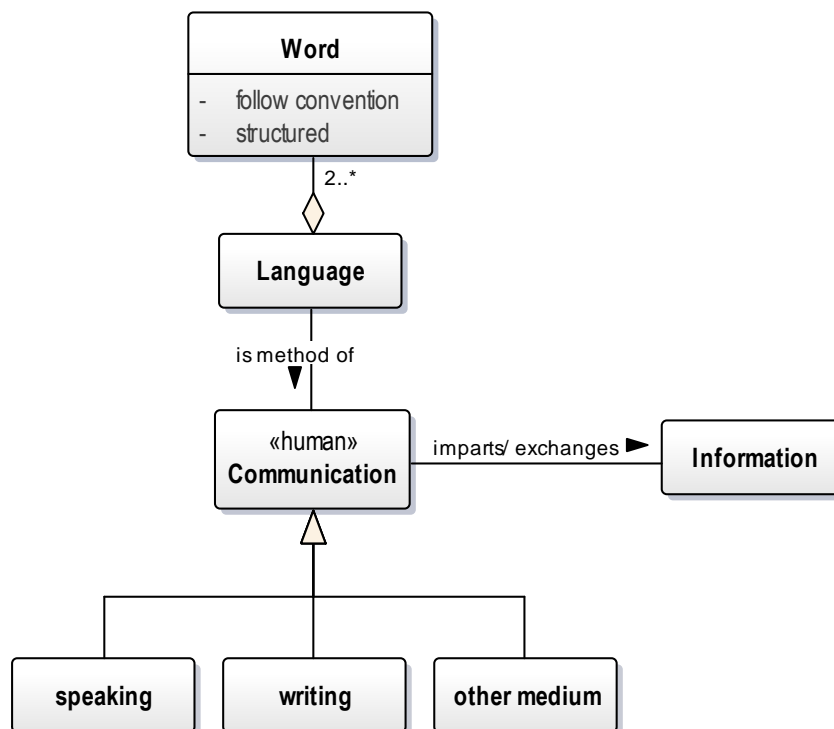


Figure 3 - Modelled definitions of *language* and *communication* (author, 2015)

The diagram shows that language is made up of two or more words which are structured and follow a particular convention. Language is a method of communication (which includes speaking, writing, and other media), and this in turn imparts or exchanges information. A benefit of this model is that it shows the required information in one place simultaneously, instead of in disconnected paragraphs. The process of modelling can be just as enlightening as the final model itself, as it obliges the modeller to truly consider the intended meaning of the information, without exploiting the ambiguity of natural language. The dictionary definition modelling exercise (Figure 3) prompted me to consider the real relationship between language and communication, thereby improving my own understanding.

Although modelling can be a very powerful tool, it is also important to consider its drawbacks. George Box famously declared that ‘essentially, all models are wrong, but some are useful’ (Box & Draper, 1987, p. 424). What he meant by this statement is that *because* models are a simplification of reality, they are inherently wrong in some respect. Take, for example, a map of the world, whose purpose is to represent certain features of the world to a particular level of detail. Box would argue that the map as a model is wrong, because it is not an *exact* representation of the world. He would find it more beneficial instead to ask if the model is ‘illuminating and useful’ (Box, 1979) – the answer to which depends entirely on the viewpoint and requirements of the user. If the user wanted to plan a car journey from the North of England to Scotland, it is likely that a map of the world would not be useful, but a road map of the United Kingdom would be more appropriate. Georg Rasch adds to the discussion that models ‘should not be true, but it is important that they are *applicable*, and whether they are applicable for any given purpose must of course be investigated’ (1960).

Recognising the inherent ambiguity in natural language, technical disciplines are increasingly choosing model-based languages to bring clarity and precision to complex concepts (Chen, 1976) (INCOSE UK, 2015) (Wegeler, et al., 2013). Modelling is highly valued within the systems engineering domain for its ability to aid understanding, demonstrate complexity, and improve communication (Holt & Perry, 2008, p. 20). There have been some attempts at

applying modelling approaches in non-traditional domains, such as managing standards (Barrow, 2005) and expressing requirements in policy (Evans, et al., 2013). In the field of strategy, Cummings and Angwin (2011) propose the use of individualised drawings to communicate strategy more effectively, which they coin *stratography*. However, there is still much progress to be made in adopting modelling activities in these new domains.

## 2.4 Summary

Communication, literally meaning *to share*, is the collaborative activity of transferring and understanding meaning. For communication to be effective, transferred information must be interpreted in the way which was intended. An alternative way to communicate complex concepts is through the use of modelling, which uses the relationships between concepts to aid understanding. Non-traditional domains, such as strategy design, could benefit from the clarity and precision that modelling techniques bring to natural language.<sup>1</sup> Furthermore, the *process* of modelling can be just as enlightening as the model itself. Whatever the choice of tool, effective communication depends on two key factors: understanding the message to be communicated, and ensuring that this meaning is accurately conveyed. This theory lays the foundation for identifying different interpretations of *strategy*, demonstrating the challenge of communicating effectively, and justifying the choice of a model based methodology in this work.

## 3 Strategy

### 3.1 The Word

The word *strategy* suffers the aforementioned ambiguity that is inherent in natural language. Since its first modern day use in the early 19<sup>th</sup> century, *strategy* has come to evoke different concepts, depending on the perspective of the recipient. Mintzberg (1988) notes that the word has ‘long been used implicitly in different ways’, yet is traditionally defined in only one.

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<sup>1</sup> The approach shall allow for a strategy to be communicated using natural language and modelling techniques



Freedman questions whether *strategy* should simultaneously denote battle plans, political campaigning, business deals, and the stresses of every-day life without actually ‘becoming meaningless’ (Freedman, 2013, p. xi). Dictionary definitions can actually contribute to the changeable use of the word, with *strategy* simultaneously attributed to different concepts – such as a *plan*, *method* or *skill* (Merriam-Webster, 2015). Used within a certain context, *strategy* might signify any one of these ideas. Even within the same organisation, perceptions of the word’s meaning can ‘differ widely’ (Danvers, 2005). Upon reading the title of this thesis, it is likely that you already had an understanding of the term based on your own experiences.

Every day use of the word *strategy* has meant that it is often applied without querying and explicitly stating its intended meaning. Freedman describes this ‘imprecise, loose and lazy’ adoption of the word in everyday speech as ‘promiscuous and inappropriate’ (2013, p. xi). Furthermore, *strategy* is often used interchangeably or confused with related words, such as *policy*, *plan* and *initiative*. Early writers on strategic management clearly differentiated strategy from other similar concepts (Andrews, 1987) (Ansoff, 1965) (Chandler, 1969), but these efforts are largely disregarded in today’s common usage.

## 3.2 The Concepts

Mintzberg (1988) suggests that explicitly recognising multiple definitions of the word *strategy* can help to address the ambiguity in this ‘difficult field’. In order to clarify the intended use of the word in this thesis, I will describe seven interpretations of *strategy* that are relevant to the research.

### 3.2.1 Strategic Thinking

Before the linguistic term *strategy* was coined, strategic thinking had long been evidenced in human behaviour (Freedman, 2013). De Waal (2007) even observes a manifestation of strategic thinking in chimpanzee communities, through self-awareness, understanding others, problem solving, and planning ahead. In a military context, strategic thinking essentially refers to the calculated use of battles to achieve the objective of war (Clausewitz, 1832). In a

corporate setting, strategic thinking has been expressed in many ways. A seminal interpretation was proposed by Chandler (1969, p. 13), who described it as ‘the determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out these goals’. Whether applied in a military, corporate, or any other context, Moore (1992, p. xiii) describes strategic thinking as ‘the determination of how an organisation, *in its entirety*, can best be directed in a changing world.’ Moore’s interpretation, valued for its simplicity, shall be known throughout this work as *strategic thinking* or *thinking strategically*.

### 3.2.2 Strategy Theory

The word *strategy* emerged from the human need to discuss the concept of strategic thinking. Before then, the earliest documented expression of strategic thinking is believed to be Sun Tzu’s *The Art of War* (c. 500BC). The word *strategy* was first used by Guibert (1779) to describe the strategic thinking demonstrated by Frederick the Great in his successful military campaigns of the 18<sup>th</sup> century. Subsequently, the discussion of strategic thinking in a military context became common from the early 19<sup>th</sup> century. Corporate strategy theory began to develop over a century later, when influential theorists such as Sun Tzu and Clausewitz were mapped to a business audience (McNeilly, 1996) (Ghyczy, et al., 2001). The field of corporate strategy theory has now grown significantly since Ansoff (1965), Chandler (1969), and Andrews (1987) laid its early foundations. Throughout this thesis, the recognition and documentation of strategic thinking will be called *strategy theory*.

### 3.2.3 Strategy Processes

My third interpretation of the word *strategy* relates to the practical implementation of strategic thinking, called *strategy processes*. In this context, the word *strategy* is usually accompanied by a verb or verbal noun, such as *strategy development* (Danvers, 2005) or *strategy implementation* (Shepherd, 2010). Strategy theory usually relates to the discussion of a particular process associated with strategic thinking, for example, decision making. Strategy processes are a prominent part of this research and will be explored in greater detail

in the work which follows. Throughout this thesis, groups of activities that are related to strategic thinking shall be known as *strategy processes*.

#### 3.2.4 Strategic Decisions

The fourth meaning of the word *strategy* applied in this work is in the context of applying strategy theory to make strategic decisions for a particular scenario. For example, ‘a strategy for moving towards zero-emission urban logistics’ (European Commission, 2011a) or ‘the strategy will increase the provision of smaller affordable homes’ (Mayor of London, 2014). In each of these examples, the word *strategy* denotes the strategic decisions that have been made in pursuit of a particular objective. Further detailed definitions are commonly proposed for this interpretation of strategy, such as Abell’s classification of strategic decisions (1980) or Mintzberg’s *Five Ps for Strategy* (1988). Throughout this thesis, the products of strategic decision making for a particular scenario shall be known as *strategic decisions*.

#### 3.2.5 Strategy (Information)

My fifth interpretation of the word *strategy* refers to the information that is produced during a strategy design exercise. This includes the purpose of the exercise, the context of the strategy, background information, strategic decisions, and rationale. For example, the design of the 2012 Rail Technical Strategy (TSLG, 2012) produced a large amount of information, only some of which was published in the Rail Technical Strategy document. By this interpretation, strategic decisions are only one type of information that constitutes a strategy. Likewise, a published strategy document does not necessarily contain all strategy information. Throughout this thesis, the information produced by a strategy design exercise shall be known as *strategy information*, or simply *strategy*.

#### 3.2.6 Strategy Document

The sixth meaning of the word *strategy* in this work is in the context of a document. The UK *General Aviation Strategy* (Department for Transport, 2015), the European Commission’s *Energy 2020 Strategy* (2011d) and the *Mayor’s Transport Strategy* (Greater London

Authority, 2010) are examples of documents which bear the name *strategy*. The use of the word in this context can often be identified by the capitalisation of the s, becoming Strategy. In general, strategy documents communicate strategy information to a specific audience, although the title *strategy* also suffers imprecise usage and is sometimes used inappropriately. Likewise, documents that do communicate strategy are often given other names, such as *Command Paper* (Department for Transport, 2012a), *Roadmap* (European Commission, 2011), or an evocative title such as *Shaping Our Future* (University of Birmingham, 2010). Throughout this thesis, the name *strategy document* shall be applied to documents which communicate strategy information, regardless of their title.

### 3.2.7 The Field of Strategy

My final interpretation of the word *strategy* encompasses the six previous concepts. It is the academic field associated with thinking strategically, applying strategy theory, performing strategy processes, making strategic decisions, producing strategy information, and preparing strategy documents. This will be known as *the field of strategy* throughout this thesis.

### 3.2.8 Overview

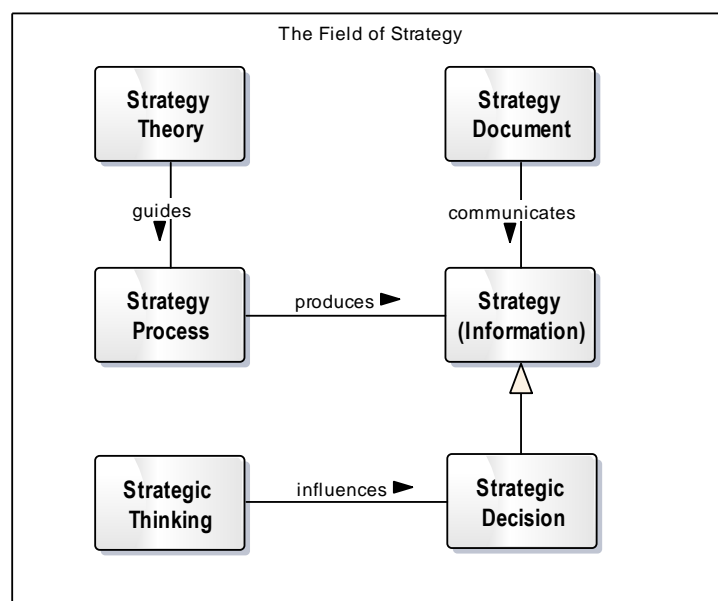


Figure 4 - concepts associated with the word *strategy* (author, 2015)

Figure 4 shows how the seven concepts described above relate to each other in the context of this thesis. Strategy processes, guided by strategy theory, produce strategy information. Strategy documents are a way of communicating strategy information, including strategic decisions, which are influenced by strategic thinking. The discipline which encompasses each of these concepts is called the field of strategy.<sup>2</sup>

### 3.3 Strategy or Policy

The relationship between *strategy* and *policy* has long been widely deliberated. Ansoff (1965) differentiates between four basic types of decision making outcomes, including those named *policy* and *strategy*. The former, he states, is made in conditions of risk or uncertainty, whereas the latter is ‘forced under conditions of partial ignorance’. Andrews (1987) considers the disciplines of *strategic management* and *business policy* to be largely comparable, while Pearce & Robinson (1988) liken *policies* to *standard operating procedures* (Moore, 1992). In a modern corporate context, popular explanations describe *policy* as the decision versus *strategy* as the direction, the headline versus the subtitle, or as the ‘blueprint’ of an organisation (Salem, 2012).

By my interpretation, the difference between *policy* and *strategy* is with regard to time. *Policy* describes an issue that is *currently* supported, for example ‘exploiting renewable sources’ (Department of Energy & Climate Change, 2015). *Strategy*, on the other hand, explains how *future* goals, such as ‘20 million less people should be at risk of poverty’ (European Commission, 2010) will be achieved, and influences the necessary *policies*. The use of the terms is often inconsistent and sometimes synonymous (Strachan, 2006), which is exacerbated by the imprecise naming of official publications as *policy* or *strategy* documents. For example, over 800 documents entitled *strategy* published by the UK Government are actually classified on its website as *Policy papers* (UK Government, 2015). Therefore,

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<sup>2</sup> The approach shall use the terminology defined in this work

government *policy* which actually demonstrates strategic thinking – that is, the expression of future direction – is also considered in the scope of this work.

### 3.4 The Processes

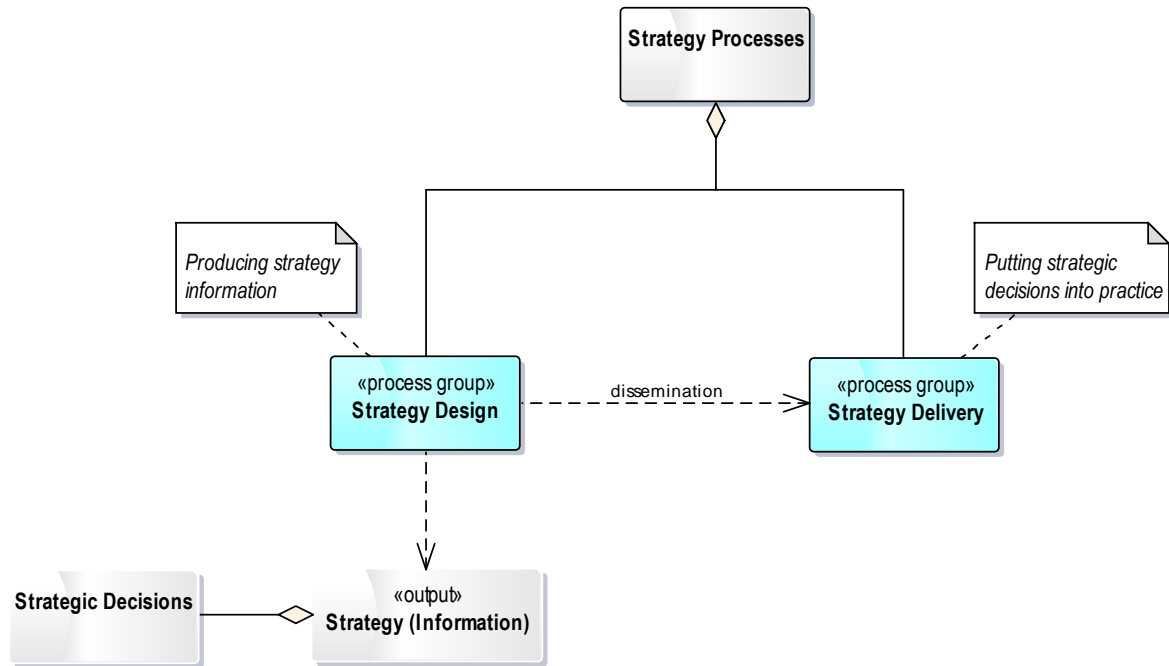


Figure 5 - The strategy process groups (author, 2015)

Strategy processes are collections of activities which are related to the field of strategy and are guided by strategy theory (Figure 4). During the course of this research, I have identified two groups of strategy processes (named *process groups*). The Strategy Design process group produces strategy information, including strategic decisions, and the Strategy Delivery process group puts these decisions into practice (see Figure 5). Dissemination means the circulation of the strategy information to a specific audience.

#### 3.4.1 Strategy Design

The act of applying strategy theory, making strategy decisions, and producing strategy information is known by many names, such as *strategy formation* (Hax & Majluf, 1991), *strategy development* (Monitor, 2014), and *strategy-making* (Hill & Jones, 2008). To avoid

evoking existing concepts associated with these terms, the novel term *strategy design* has instead been used in this work. A further reason for adopting this term is that the existing vocabulary tends to concentrate on *strategic decisions* alone. It does not take into account the other activities that are required to produce the information comprising a strategy. The word *design* has been purposefully selected to reflect the popular view of strategy as a creative process (Wing, R.L., 2000) (Lafley, et al., 2012) (Mulgan, 2008), yet one which requires systematic effort.

### 3.4.2 Strategy Delivery

The act of putting strategy into practice is often called *implementation* (Lee & Puranam, 2013) (Shepherd, 2010) (White, 2001), but it can also be known by other names, such as *execution* (Neilson, et al., 2008) (Sull, 2007). Again, to avoid evoking existing concepts associated with those terms, I have adopted the term *strategy delivery* for the purpose of this work. The name is also reminiscent of engineering projects, where a concept is developed into a design and then delivered.

## 3.5 Communicating Strategy

The success of a strategy is often measured by how effectively it has been delivered (Outram, 2014). This means how well the *strategic decisions* have been translated into appropriate organisational arrangements (Neilson, et al., 2008). In other words, if strategy design is the ‘thinking’, then delivery is the ‘action’ (Reeves, et al., 2015). The effectiveness of strategy delivery commonly depends on the extent to which an organisation’s actions *correspond* to its strategic intentions (Puranam, 2014). Therefore, the perceived success of a strategy is not solely dependent on the quality of its decisions, but more crucially, on their successful communication. Cummings and Angwin (2011, p. 435) believe that a strategy which is not understood by those responsible for delivering it is ‘as bad as, or even worse than, not having a strategy at all’.

Some even suggest that the effective delivery of *poor* strategic decisions can ultimately lead to success for an organisation (Lee & Puranam, 2013). In which case, the effective translation of strategic decisions can be as influential as the decisions themselves. O'Donovan and Flower (2013) allude to Box's famous quote (1987) in claiming that 'every strategy is wrong', but strategy 'in a way helps you learn what is "righter"'. In other words, just as the *process* of modelling can prove to be as helpful as the model itself, so the *process* of strategy design can bring significant value. The lesson to take from these reflections is that the success of a strategy, and even an organisation, depends on the gap between strategy design and strategy delivery, that is, where strategic decisions are disseminated.

As will be demonstrated in Chapter 4, strategic decisions are typically communicated in strategy documents using natural language. However, as discussed, natural language can actually be a barrier to effective communication (Kovačević, 1995) (Sayer, 2013). Codd (1988) even suggests that decision makers purposefully exploit the language used in these documents to 'engineer' the consent of the readers, by using divergent meanings, contradictions and structured omissions. In one survey on perceived barriers to strategy delivery, *communication problems* received the second highest response behind *motivation and personal ownership issues* (Johnson, 2002).

In another study, almost 20% of the respondents felt that strategic decisions were not well-defined, resulting in poor delivery (Shepherd, 2010). One respondent commented that strategy information 'does not get translated effectively and/or efficiently from leadership through the ranks to those who implement/execute the activities'. Another reflected that 'when we separate strategy from execution, we have a problem'. Communication problems are also commonly blamed for failures in the delivery of public services. The Rail Value for Money Study (McNulty, 2011) called for a clearer view between high level decisions for Britain's railways and their delivery. Likewise, an investigation into the UK's immigration agency (UKBA, 2012) concluded that 'there was a lack of clarity in the language used with consequent ambiguity when decisions were converted to operational practice'.



The separation of strategy design from strategy delivery commonly causes concern in relevant literature. Puranam (2014) describes this as a separation between *beliefs* and *actions*, where ‘the people who come up with strategies and refine them are generally not those who implement them’. To ensure success, complex ideas must be communicated effectively from the decision makers to the delivery team. Academics and practitioners have proposed tools and approaches to close the design and delivery ‘gap’ (White, 2001) (Antola, et al., 2006) (Sull, 2007). Kaplan and Norton’s work on the balanced scorecard system (1996) addresses the challenge of ‘translating’ strategy information into ‘terms that can be understood and acted upon’. However, these initiatives are generally proposed during the delivery phase, after the strategy has been completed. Sebitosi (2008) takes another view, blaming the disparity between what a strategy states and what is delivered on the *whole* approach, from the choice of contributing stakeholders to the document review process.<sup>3</sup>

### 3.6 Existing Approaches to Strategy Design

There is no single universally adopted approach to strategy design (CFAR, 2005) (Pretorius & Maritz, 2011) (McNamara, 2015). Rather, there are many different approaches and ‘plenty of debate’ about which one is the best (Brown, 2012). Since the early work on strategy theory in the 1960s, academics and practitioners have contributed many new tools and approaches. As one CEO speculated, ‘by now, the number of books about strategy probably exceeds the number of viable and sensible strategies developed in the history of capitalism’ (Outram, 2013). Despite this quantity, a study by McKinsey & Company (2006) reveals that 77% of the companies surveyed *do not* follow a formal strategy process. Brown observes that, despite claims to the contrary, none of the established approaches suits all organisations at all times, leading to ‘lots of different models for strategy, more than a little confusion, and numerous calls to come up with a better way’ (Brown, 2012). Certain prominent tools, such as the S.W.O.T. analysis technique (Goodrich, 2015) and Porter’s Five Forces schema (2008) are

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<sup>3</sup> Communication shall be considered during strategy design

commonly applied, but overarching approaches vary according to the particular scenario and perspectives of those involved. Existing formalised approaches to strategy processes are either directed at a corporate audience<sup>4</sup> or focussed solely on decision making activities<sup>5</sup>. The lack of a universally adopted strategy design approach in complex multi-stakeholder environments results in inconsistent outputs of varying quality (see Chapter 4).

### 3.6.1 Corporate Strategy

Literature in the field of strategy is saturated with guidance aimed at a corporate audience. Proposed approaches to strategy design include Hax and Majluf's *methodology for the development of a strategic plan* (1991), which is intended to guide users through an 'orderly sequence of logical steps'. Although my research mirrors the intention of this work, the heavy theory in the book and the focus on 'the firm' does not make it an obvious choice for strategy design in public domains such as power, transport and healthcare.

Wheelen and Hunger (2011) propose a *strategic management model* which identifies four 'basic elements' of strategic management and describes the steps that make up each element. The guidance is dense and written in corporate language, again making it largely inaccessible to other types of strategy. Furthermore, the focus of the model is on making strategic decisions, rather than designing the whole strategy.

Sull (2007) suggests a four step iterative approach which challenges the typical separation of strategy design and strategy delivery. Instead, he describes an 'ideal world' where strategies are designed and delivered by the same people. This proposition would entail considerable reform of shared public and private systems, where overall strategy is today generally set by a government and communicated to those who deliver it through official publications, such as Energy 2020 (European Commission, 2011d), the General Aviation Strategy (Department for Transport, 2015), or the Mayor's Transport Strategy (Greater London Authority, 2010).

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<sup>4</sup> The approach shall be generic (suitable for any audience)

<sup>5</sup> The approach shall consider all activities associated with strategy (not solely decision making)

### 3.6.2 UK Government Strategy

Compared with corporate strategy theory, there is notably less published guidance on designing government strategy. The UK Government follows a broad cycle for making policy (i.e. *strategy design*) which is named ROAMEF in some departments and agencies cycle (HM Treasury, 2003). However, many feel that the model is idealistic and does not reflect how government strategy is actually developed in the 'real world' (Institute for Government, 2011) (Aldred, 2013). Comprising six steps (Rationale, Objectives, Appraisal, Monitoring, Evaluation, Feedback), the cycle is again focussed on the decision making aspects of strategy, providing minimal guidance on how best to communicate the decisions to those who will deliver them.

### 3.6.3 Strategy Design for the UK National Health Service

The UK's National Health Service (NHS) is facing new challenges, namely, increasing complexity, a changing demography, budgetary constraints, and external pressures to improve quality (Eckert, et al., 2014). The same challenges are plainly evident for other public services, such as transportation, water and energy, which are all becoming increasingly complicated and complex, and involved in further public private partnerships. In light of the challenges to the NHS, there have been recent calls for more collective approaches to leadership and strategy (West, et al., 2014).

In 2014, a *strategy development toolkit* was produced for the NHS, containing guidance on 'each stage of developing a strategy' for foundation trusts (Monitor, 2014). The intention of my research to provide pragmatic guidance, including examples and further references, to those responsible for designing a strategy, reflects the purpose of the toolkit. The NHS work also recognises the influence of a strategy's quality on whether the organisation will achieve its aims (p. 4). However, in the toolkit, the question of effective communication is not considered until *after* the strategy has been designed. As discussed, this is a common drawback in existing strategy approaches, which often only consider communication during the delivery of strategic decisions (White, 2001) (Antola, et al., 2006) (Sull, 2007). However,

if effective communication is dependent both on the recipient and the sender (Thompson, 2011, p. 15), it should be taken into account during the strategy design phase, when the produced information is *sent*, as well as when it is *received* during delivery.

#### 3.6.4 Strategy Design for the British Railway System

There is no single formalised approach to strategy design for Britain's complex, multi-stakeholder railway system (Gaynor, 2014) (Randall, 2014) (Brennan, 2014). Certain strategic decisions are made at a governmental level, whereas others are a collaborative effort across different industry stakeholders, as discussed further in Chapter 3. Accordingly, strategy documents are regularly published by government, industry partnerships, and private organisations alike. The approach chosen for designing the Rail Technical Strategy (TSLG, 2012) was based on a review of models used by other organisations, including that of the Ministry of Defence and relevant international examples. The options were debated before deciding which approach would be adopted (Brennan, 2014). Chapter 3 will consider in more detail how other railway strategies are designed, including at a European level.

#### 3.6.5 Communication Approaches

Despite the lack of focus on communicating strategic decisions in existing approaches, some guidance does exist, such as *How to Write a Strategic Plan* (Olsen, 2010) and *Strategic Plan Template: What To Include In Yours* (Lavinsky, 2013). However, such guidance tends to provide general advice on what to include in a strategy and how to write clearly, without actually proposing a systematic process. The European Commission offers guidance to its staff on *how to write clearly* when drafting any type of official documents (European Commission, 2015b), and advice on writing in a concise, unambiguous manner in texts which are destined for translation (Piehl, et al., 2014). The widely used balanced scorecard system (Kaplan & Norton, 1996) *translates* strategy information into 'tangible objectives and measures', but is a tool for strategy delivery, not for strategy design (p. 78). Cummings and Angwin's *stratography* approach (2011), which uses individualised drawings to communicate strategy,

is again aimed at the onward delivery of a completed strategy.<sup>6</sup> The Goal Structuring Notation (GSN) is a widely used approach for communicating safety arguments (GSN Working Group, 2011). Although the GSN is not directed at strategy design, the idea of capturing evidence and context for each argument has potential benefits for the communication of strategic decisions.

### 3.7 Summary

In this section, I have addressed what is interpreted by the word *strategy*, introduced the concept of strategy design, and explored why current approaches to strategy design are insufficient. I have also considered some of the challenges faced by complex sectors in designing strategy. I have found that common use of the word *strategy* can be varied and imprecise. Furthermore, the term *policy* is often used to represent strategic thinking, and there has historically been inconsistent and confusing use of both words. Interpretations of *strategy* depend on the context and experience of the recipient. To avoid ambiguity, I have described seven concepts associated with the word *strategy* that will be used throughout the thesis: strategic thinking, strategy theory, strategy processes, strategic decisions, strategy (information), strategy document, and the field of strategy.

I have also identified two groups of strategy processes: Strategy Design, which produces strategy information including strategic decisions, and Strategy Delivery, which puts these decisions into practice. The success of a strategy is often measured by how well it has been delivered. However, successful delivery is dependent on the effective communication of strategic decisions. Although existing approaches in the field of strategy recognise the importance of effective communication, they are usually focussed on the delivery of a completed strategy. In the following section, I will explore how systems thinking has historically influenced strategy design and describe the potential for further areas of influence.

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<sup>6</sup> The approach shall include guidance for communicating strategy

## 4 Systems Thinking

Aristotle's early expression of holistic or *systems* thinking, as set out in *Metaphysics* (Gladstone, 2006), is often summarised as the idea that *the whole is greater than the sum of its parts*. Skyttner (2001) recognises systems thinking as far back as the Middle Ages, where morality and heavenly systems were viewed as being connected with physical and worldly systems to create one entity (p. 5).

### 4.1 Systems

The word *system* emerged in the early 17<sup>th</sup> century, and unlike *strategy*, there is generally a consensus regarding its meaning. The International Council on Systems Engineering describes a system as 'an integrated set of elements that accomplish a defined objective' (INCOSE, 2000). By this definition, a system is an entity comprising smaller, connected parts that share a purpose. Classical sciences attempted to understand systems by reducing them to their smallest parts. However, this reductionist approach was unable to explain the complex problems of the modern world, such as environment destruction, therefore systems thinking began to evolve from the 1920s (Skyttner, 2001). Systems thinking considers 'the interconnections between parts of a whole', rather than 'concentrating just on the parts' (The Open University, 2011) and as such, has the aim of 'fostering generalists qualified to manage today's problem better than the specialists' (Skyttner, 2001, p. 38).

#### 4.1.1 Complex and Complicated

The terms complex and complicated have specific connotations in the area of systems thinking. Gawande (2011) describes complicated problems as 'ones like sending a rocket to the moon' (p. 49). They often require multiple teams of specialised expertise and unanticipated problems are common. Complex problems, on the other hand, are 'ones like raising a child' (p. 49). Successfully raising one child may provide experience, but the next child might require an altogether different approach. It is possible for a given system to address both complicated and complex problems, as well as simple and chaotic, as defined in the Cynefin framework

(Snowden, 2000). Cowper et al. (2014) discuss the importance of applying the right approach in each of these problem spaces.

The terms *complex* and *complicated* can also be used to characterise the structure and context of a system. A complicated system is one which has a large number of relatively basic entities that can be managed through careful planning, leadership, and policy implementation. The behaviours of such systems can be predicted with a reasonable degree of certainty. Complex systems, by contrast, are made up of ‘web-like independent and interdependent relationships’ (Strauss, 2014), which frequently experience unpredictable events and interactions that do not obey well understood laws or rules. The British railway system of systems, which is used as an example in this research, can be described as both complicated and complex. It comprises a large number of entities that can be managed normally through planning, leadership and policies. However, it also features many systems whose relationships are not fully understood or whose behaviours cannot be predicted. Although the systems discussed in this thesis are generally described as *complex*, this should be understood to include both the complex and complicated characteristics described above.

## 4.2 Systems Theory

Building on Bell Laboratories’ early cybernetics work in the 1930s (Black, 1977), Ludvig von Bertalanffy (1950) coined the term *General System Theory*; a discipline which he considered to be ‘applicable to all sciences concerned with systems’. The work was in response to what von Bertalanffy called the *Parallel Evolution in Science*, where various branches of science had independently developed similar general concepts and viewpoints. The International Society for General Systems Theory (now the International Society for Systems Science) was founded in 1954, with the aim of linking these disaggregated disciplines with an overarching *law of laws*, named General Systems Theory (Skyttner, 2001, p. 36). Following this early work on the behaviour of systems and faced with ever-increasing complexity in the modern world, scholars have greatly furthered the field of systems theory in a period dubbed The Systems Age (Skyttner, 2001). From Checkland’s *Soft Systems Methodology* (1981) and Senge’s *The Fifth*

Discipline (1992), to the more recent Snowden's Cynefin Framework (2000) and Taleb's The Black Swan (2007), the knowledge and application of systems principles continues to grow (Cowper, et al., 2014).

### 4.3 Systems Thinking in Practice

Some of the earliest published work on systems thinking in practice was produced by the scientific management movement in the early twentieth century. As a remedy to the inefficiencies suffered by the United States at the time, the movement proposed a *systematic management* approach, which included theories and practical tools (Taylor, 1911). The application of systems thinking became truly established following the Second World War, during which time a new 'emergency-discipline' called *operational research* emerged. Recognising the benefits that collaboration and whole system thinking had brought during wartime, the United States established Project RAND (Research AND Development), which focussed on *systemic* military decision making (RAND, 2015). The project, which evolved into today's RAND Corporation, has contributed a number of influential decision-making tools and theories that have had an extensive impact on modern systems thinking.

### 4.4 Systems Thinking in Strategy Processes

The influence of systems thinking on the development of strategy theory is well recognised. Clausewitz's early commentary on military strategy theory describes how Frederick the Great bound together the results of individual combats 'into an independent whole' (1832, p. 115). Moore (1992) attributes early developments in corporate strategy theory to the evolution in systems thinking taking place at the time, specifically drawing on Bertalanffy's General Systems Theory (1950). In Andrews' influential work on corporate strategy theory (1987), he introduces a view of the organisation *as a whole*, considering it as an entirety 'purposefully relating to the world about it' (Moore, 1992, p. 7).

In the 1960s, the RAND organisation began to extend systems approaches to non-traditional processes (Quade, 1969). It has since played a focal role in applying systems thinking to



strategic decision making. Systems Analysis, the organisation's 'signature methodological innovation' (Jardini, 1996), has now become an important part of the systems engineering discipline (INCOSE, 2006). The technique allows for the systematic examination and comparison of alternative courses of action in order to support decision making (RAND, 1996, p. 47). In *Systems Thinking Strategy* (2012), Brown suggests that organisations perform better if they take a systems thinking approach to strategic decision making. The relevance of systems thinking to strategy processes has been well recognised, and there are common calls for its application (INCOSE, 2012) (McNulty, 2011) (Brown, 2012).<sup>7</sup>

## 4.5 Systems Engineering

### 4.5.1 Overview

Systems engineering (SE) is the specific application of systems thinking for developing and managing complex systems (INCOSE, 2004). Systems thinking provides the 'key intellectual underpinning' for systems engineering and is considered to be an essential skill' for systems engineers (INCOSE UK, 2010a). Kasser and Mackley (2008) also believe that the ability to perform systems thinking is a 'critical competency' for a systems engineer. Systems engineering practices initially became established in the defence, aerospace and software industries (Weigel, 2000), but have since extended to less traditional disciplines. Today, it is embedded in organisations such as BAE Systems, the Ministry of Defence and Network Rail, and has become the 'dominant paradigm' for delivering complex systems in the early 21<sup>st</sup> century (Cowper, et al., 2014).

### 4.5.2 Background

One of the principal focuses of systems engineering is to understand what is required of a system *early* during its development (INCOSE, 2004). It is widely recognised that the early stages of a project are highly influential in delivering ultimate success (The Standish Group, 1995) (Morris, 2005) (Atkins, 2011). The Cost Influence Curve (Figure 6) shows that by the

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<sup>7</sup> The approach shall demonstrate systems thinking

development phase of a project, approximately 60% of the overall cost has been committed. This means that changes to scope later in the lifecycle are likely to cause disproportionate costs. A report by the Standish Group (1995) identifies the top reasons for project failure as *incomplete requirements* and *lack of user involvement* – both occurring early in the development lifecycle.

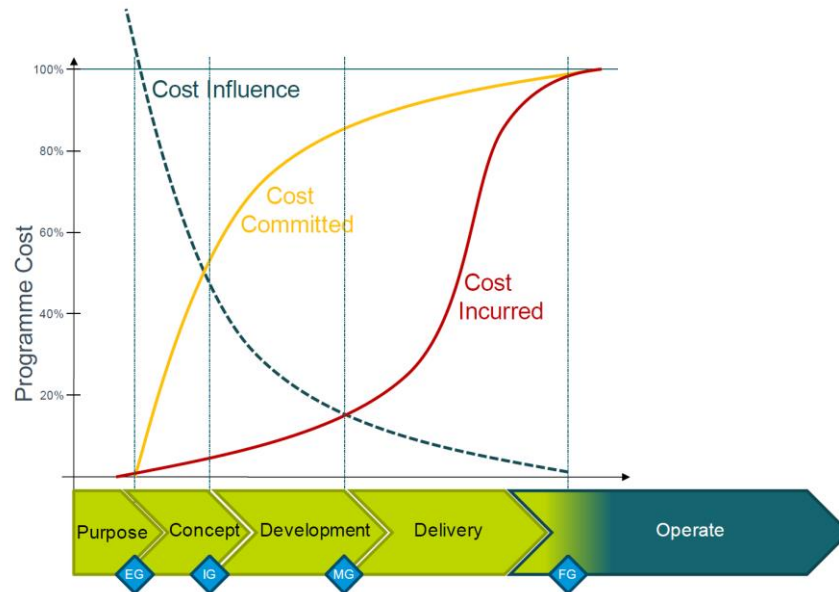


Figure 6 - The Cost Influence Curve (Atkins, 2011)

Where public spending is required, as is commonly the case with the multi-stakeholder systems addressed in this research, there is public scrutiny of project spending. In Britain, the National Audit Office (NAO) is responsible for holding government to account and investigating any project failures in the public domain. In a list of 8 Common Causes of Project Failure (2002), the NAO highlights the lack of a clear link between a project and the organisation's strategic priorities as a common problem. Again, this is an issue which should be observed and addressed early in the project. Systems engineering recognises the influence of the early stages of system development and therefore focusses effort in this area.

### 4.5.3 Application

Traditional systems engineering application is commonly described using the v lifecycle model (Figure 7). SE practice typically begins at the requirements definition stage on the upper left of the model and continues through to the assessment of the system's value. In some cases, systems engineers intervene earlier to assist clients with understanding the problem space. However, their advice is rarely sought *before* a project is conceived.

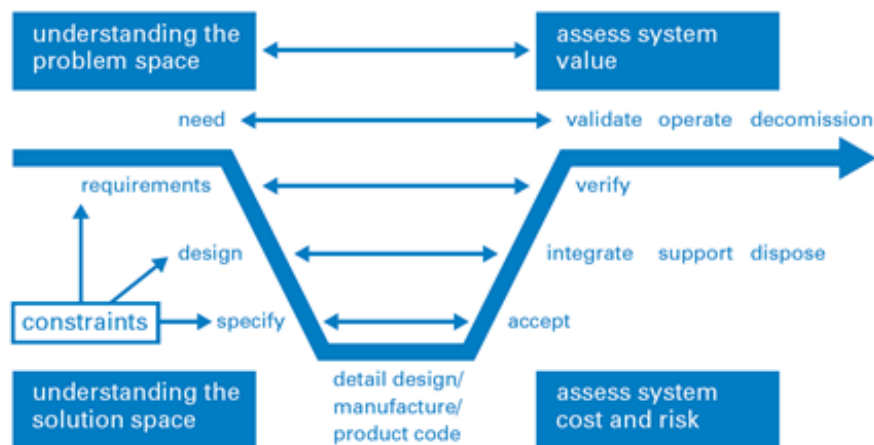


Figure 7 - The v lifecycle model (INCOSE UK, 2009)

Ring (1998) proposes an alternative view of the lifecycle of a system (Figure 8), showing a cyclical pattern where the focus shifts between value, purpose and solution. Strategy processes, which articulate the need for change and define benefits, appear in the *focus on value* and *focus on purpose* spaces. Systems engineering processes, by contrast, typically serve the *focus on solution* space, which mirrors the space shown in the v lifecycle model. In this work, I propose the application of certain systems engineering practices in the strategy design space.

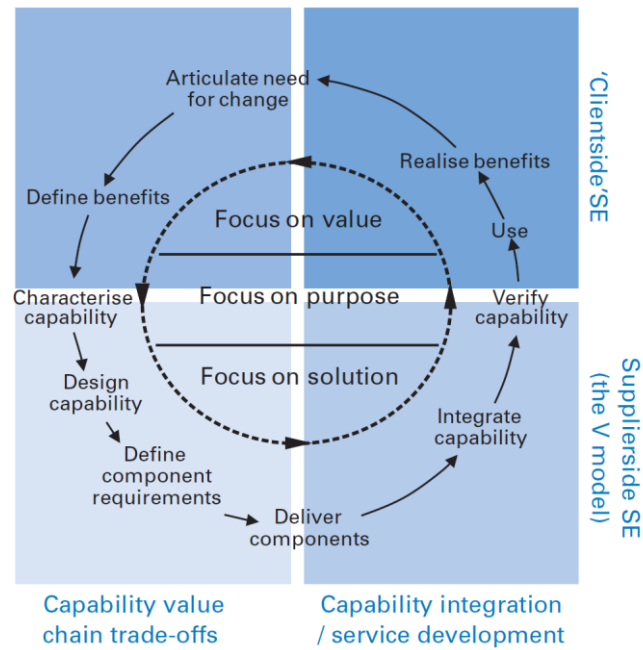


Figure 8 - Adaptation of Ring's value cycle (INCOSE UK, 2014)

#### 4.5.4 Systems Engineering for Strategy Design

The effectiveness of strategy delivery is often measured by how well an organisation's actions correspond to its strategic intentions (Puranam, 2014). Likewise, the success of an engineering project is often judged by how well the initial requirements have been met. Effective communication is crucial to achieving success in both of these contexts. In the systems engineering domain, substantial effort is made to understand a customer's needs, to capture them accurately, and to communicate this information to the multiple stakeholders who will deliver the solution. As will be demonstrated in Chapters 3 and 4, effective communication is often overlooked in strategy design, resulting in the ambiguous expression of strategic decisions (Evans & Roberts, 2013) and inconsistent language usage (Mason, et al., 2012). In today's complex, multi-stakeholder sectors, where every action has a possible impact on other systems and on the wider environment, a systems approach to strategy design is necessary.

#### 4.5.5 The Communication Challenge

Language is a recognised barrier to applying systems engineering in non-traditional domains and one which I face in this work. Chase (1974) describes the 'tremendous language difficulties

to be overcome' in order to communicate systems thinking effectively and to describe the systems engineering approach. Brill (1998) and Weigel (2000) comment on the confusion surrounding language and terminology in the systems engineering domain and the inconsistent use of the term *systems engineer*. Even Skyttner's recent explanation of systems engineering is heavily biased towards software systems engineering (2001, pp. 412-415), which is no longer the principal application area of the term. In order to extend systems engineering concepts and practices beyond traditional industries, the International Council on Systems Engineering has called for the improved accessibility of systems engineering language (INCOSE, 2012). In light of this communication challenge, the approach presented in this thesis translates systems engineering practices for strategy designers.

## 5 Summary

In this chapter, I have begun to address the five research questions established in the Introduction. I have described the varied and imprecise use of the word *strategy* and defined seven different interpretations that are evident in relevant literature. These definitions will be used to inform the approach presented in Chapter 5. I have identified two groups of strategy processes and reviewed relevant literature on the strategy design process group. The review shows that although there has been a great deal of research in this area, existing literature tends to focus on making strategic decisions. There has been limited study into the whole life of a strategy, from inception to replacement or withdrawal, which is where my research contributes.

The literature review also indicates that there is no universal formalised approach to strategy design. The approaches which do exist either focus on decision making activities, or are targeted at a corporate audience. As a result, strategy design is generally carried out in an informal, fragmented manner. The review shows that although systems thinking has long been valued in the making of strategic decisions, its practical application is lacking when communicating those decisions. In complex, multi-stakeholder sectors, where design and delivery activities are often the responsibility of different stakeholders, effective

communication is particularly critical. In light of this review, I believe that there is a need and a place for more systems thinking in strategy design. In the following chapters, I will set out a formalised approach for achieving this which is based on principles from the systems engineering domain.

# CHAPTER 3

## THE BRITISH RAILWAY EXAMPLE

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### 1 Introduction

Having introduced the concept of strategy design in the previous chapter, I now address the particular challenge of designing strategy for the increasingly complex, vertically separated sectors of modern society. To do this, I use the example of the British railway industry, where strategic decisions are made by multiple stakeholders at different hierarchical levels. The case study serves as a lesson to other sectors, such as healthcare, water and energy, which are increasingly evolving into similarly complex and complicated structures. In the following chapter, I describe why the traditional military model for communicating strategic decisions is not suitable for such sectors. I introduce the background and context of the British railway system and describe its structure, decision making processes, and approaches to strategy design. I then present an overview of four influential documents in the sector, from a high level strategy paper to a detailed technical specification. The chapter serves to inform the evaluations carried out in Chapter 4 and the approach proposed in Chapter 5.

### 2 The Military Model

The modern application of strategic thinking originated in a military context, when leaders first began to plan battles carefully in order to achieve the ultimate objective of war rather than exclusively winning a particular battle. In the military model, strategic decisions are made by a commander and commonly communicated verbally through a hierarchical chain of command (British Army, 2010). Strategic decisions are linked through the command structure to tactical and operational instructions. This relies on mutual understanding, clear communication, and coordination at every level. Subordinates know the intentions of superiors who are two levels above their own and understand how their own missions relate to others at their level (p. 06:13). This approach to strategy communication is effective in a

military context, where organisational structures are vertically integrated, decision making is top-down, and decision timelines are relatively short. Today, by contrast, the increasing emergence of complex, multi-stakeholder systems requires a different, systems approach

### 3 The Single European Transport Area

Complexity in decision making is especially evident in the European Union (EU), where each individual Member State is not only part of a political system, but also part of a wider, operational system. Since its origins in the 1950s, the economic goal of the EU has been the creation of a single market for goods, services, money and people, which is free of technical and institutional barriers to trade (European Union, 2015). As part of this aim, there has been a longstanding vision to create a Single European Transport Area. For European railways, this vision has had significant technical, operational and organisational implications. Under the Treaty of Lisbon (2007), transport is considered to be a shared competence, meaning that both Member States and the European Union are authorised to adopt binding legislation in this area. In 2001, the European Parliament adopted the First Railway Package, a set of EU Directives aimed at allowing open, non-discriminatory access to the European rail network for rail operators (European Commission, 2012). This was to be the first of four sets of legislation seeking to encourage competitiveness and efficiency in the EU railway system of systems through 'gradual liberalisation' (Butcher, 2013).

The recent Fourth Railway Package makes further attempts to achieve these objectives by requiring the legal, financial, and operational separation of railway operations from the infrastructure manager in each Member State (European Parliament, 2013). Critics argue that further vertical separation, as has already been adopted in Great Britain, could create further misalignment of objectives, thereby increasing costs (Nash, et al., 2014). Supporters, by contrast, believe that this change would bring growth, better services, lower prices, and environmental benefits (Berkeley, 2013). Without doubt, full separation of EU railway systems will introduce more stakeholders, create extra interfaces, and further complicate decision making processes. Therefore, the effective communication of strategic decisions will become



even more critical. Britain's railway system offers an example to the rest of Europe of the challenges involved in designing and delivering strategy for a vertically separated system.

## 4 The British Railway System

### 4.1 A Complicated and Complex Structure

Britain's railway system has undergone much structural reform since its origins as a patchwork of independently operated railway companies in the middle of the 19<sup>th</sup> century. Following the Second World War, the whole system became vertically integrated as state-owned British Railways (BR). Strategic decisions during that time were led by government, with advice from BR's board, who managed both the infrastructure and operations. From 1992, in line with the privatisation of other core services such as water, electricity, telecommunications, oil, and gas, the Conservative Government initiated the denationalisation of Britain's railway system. By 1997, a complicated new structure was in place where operations, infrastructure and maintenance were managed by different private stakeholders.

Although the ownership of the infrastructure and its management have since been returned to the State under Network Rail, Britain's railway system of systems remain complex and vertically separated, and involves many stakeholders. Today's structure is based on the principle of public and private partnership, where the public service is specified by government and delivered by the private sector. The Government has largely retaken charge of strategy; setting the level of public expenditure and strategically deciding what this should buy (Department for Transport, 2004). The fragmented structure of the system, which has brought a greater number of interfaces, further interactions and more stakeholders, is frequently blamed for perceived failings of the railway, such as inefficiency and poor customer value (Smith, 2011) (Wolmar, 2011). In light of this, there are even calls by prominent politicians for the re-nationalisation of the system (Burnham & Dugher, 2015) (Corbyn, 2015).

## 4.2 Stakeholders

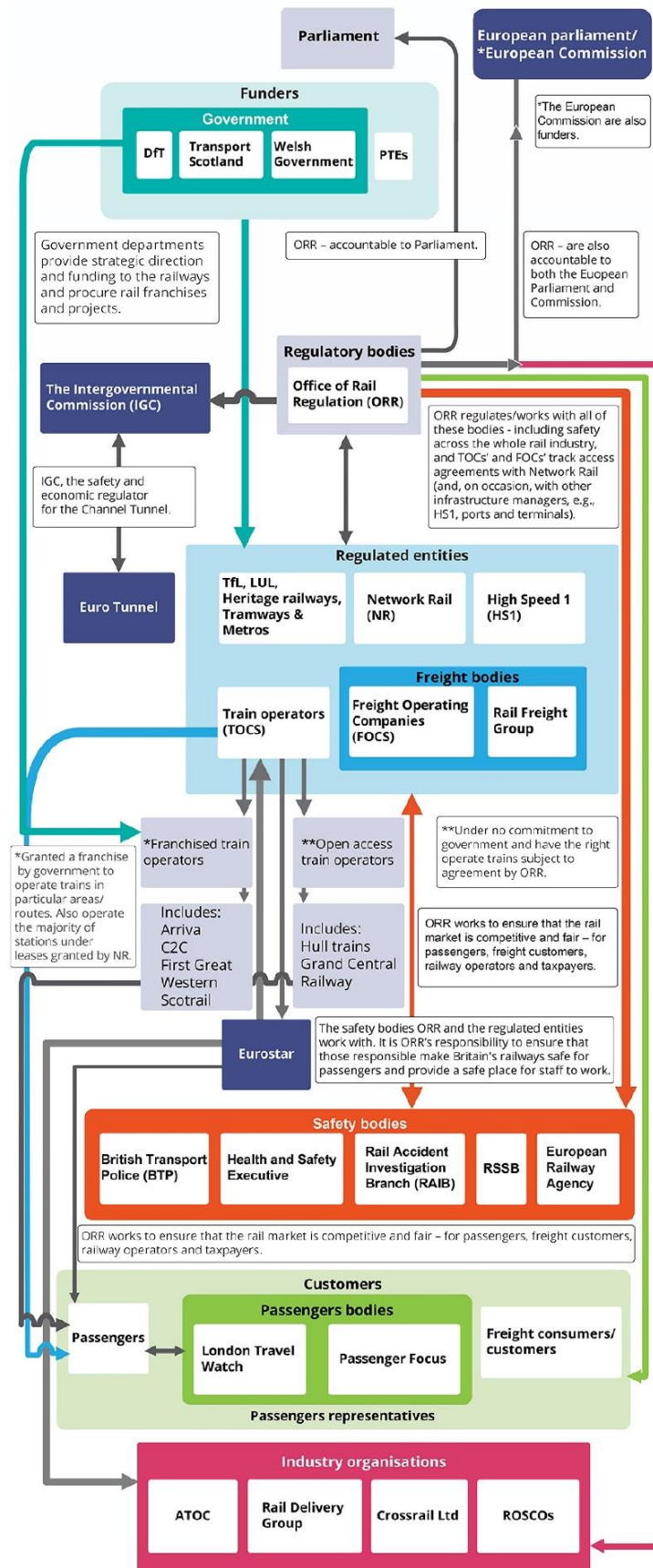


Figure 9 - An overview of the British rail industry (ORR, 2015)

Britain's railway system comprises public bodies, private companies, and third sector organisations. Figure 9 shows an overview of the industry's structure, key strategic decision making processes, and funding streams. The infrastructure is publicly owned and maintained under the stewardship of Network Rail, which became a government body in autumn 2014 and is accountable to independent bodies such as the Office of Rail and Road. Passenger services are operated by train operating companies (TOCs), for example Virgin Trains, which must fulfil requirements set out by the government's Department for Transport in franchising agreements or management contracts. Privately owned freight operating companies (FOCs), such as DB Schenker, liaise directly with Network Rail to obtain track access and pay the applicable cost. The trains are owned by private rolling stock leasing companies or directly by freight operating companies.

### 4.3 Communicating Strategic Decisions

The fragmentation of Britain's railways into many businesses has been blamed for a lack of coordination and clarity often present in decision making for the industry (McNulty, 2011). Strategic decisions for the railways are commonly communicated through a strategy document.<sup>1</sup> In Figure 10, I demonstrate the complexity of decision making for Britain's railway by presenting some of the many strategy documents which have been published in recent years. The illustration shows the source of each document and the intended recipient. Further descriptions of the different types of strategic decision making are provided below.

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<sup>1</sup> The approach shall provide guidance for producing a strategy document

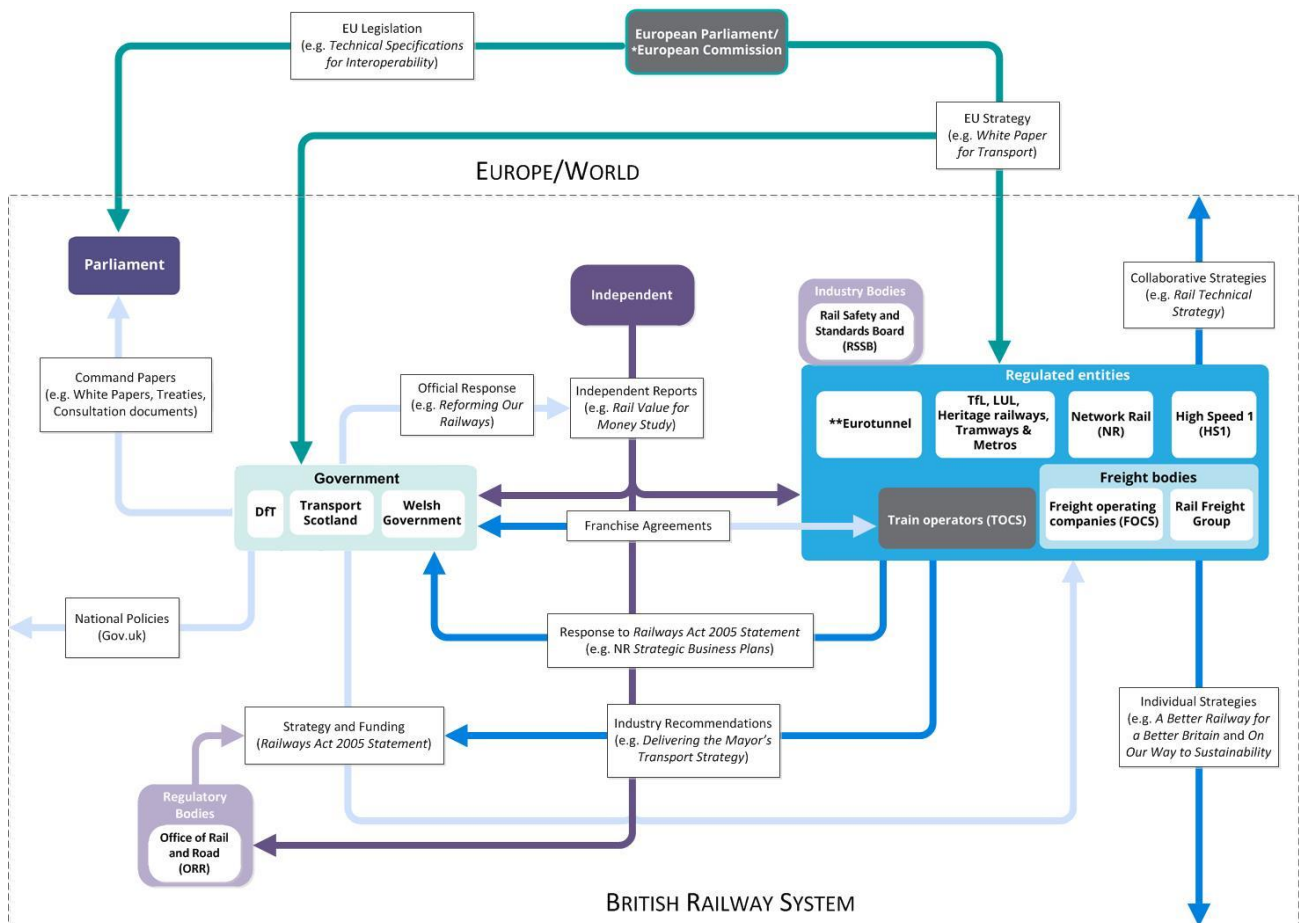


Figure 10 - An overview of decision making in the British railway industry (author, 2015)

#### 4.3.1 Government and Parliament

Britain's national rail policies, for example *Expanding and improving the rail network*, are communicated through the Government's website (DfT, 2012). Official information and decisions about rail (and other public sectors) are presented to Parliament by Government in publications called Command Papers, which include; White Papers setting out the details of future policy, treaties and international agreements, consultation documents, reports, and official responses. Every five years, the Department for Transport publishes its national rail strategy in a Railways Act 2005 Statement, which informs Network Rail what the Secretary of State wants to be achieved (High Level Output Specification) and the public funds that are likely to be available (Statement of Funds Available). In developing the strategy, the

government receives recommendations from industry in documents such as *Delivering the Mayor's Transport Strategy* (Transport for London, 2011).

#### 4.3.2 Infrastructure Manager

Network Rail (NR) provides a formal response to the Government's requirements set out in the Railways Act 2005 Statement in the form of Strategic Business Plans, which describe NRs strategy and detail the proposed schemes to be taken forward. In addition to this official process, Network Rail also publishes its own strategy documents, such as *A Better Railway for a Better Britain* (2013) and its *Technical Strategy* (2013b).

#### 4.3.3 Operators

Passenger operators are required to meet the requirements set by Government in franchise agreements such as the *Intercity East Coast Franchise Agreement* (Secretary of State for Transport, et al., 2014). Operators also publish their own strategy documents in line with their business goals, for example *On our way to sustainability* (Virgin Trains, 2015) and Southeastern's *Customer and Stakeholder Engagement Strategy* (2014).

#### 4.3.4 Collaborative and Independent

In recent years, a number of strategy documents have been published as a collaborative effort between related stakeholders. These include the *Rail Technical Strategy* (TSLG, 2012), which set out a common industry vision for Britain's railways, and the *Long Term Passenger Rolling Stock Strategy for the Rail Industry* (RSSSG, 2014). Occasionally, independent reports are commissioned to provide strategic recommendations to the Government and industry. The *Rail Value for Money Study* (McNulty, 2011) was commissioned to identify potential areas for improved efficiency and better value for money in the rail industry. In return, the Government will often provide an official response to such reports in the form of an official publication, such as *Reforming our Railways* (Department for Transport, 2012a).

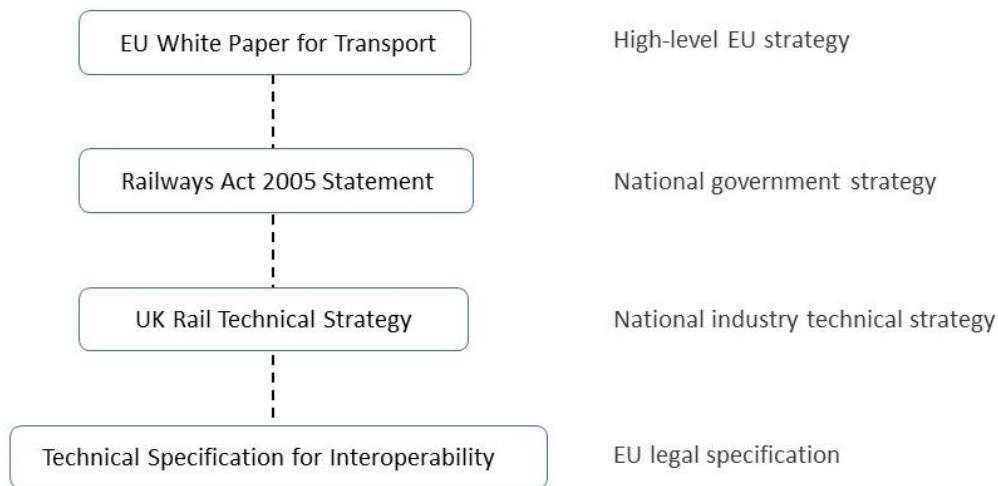
#### 4.3.5 Europe

Being located in a Member State of the European Union, Britain's railway system is impacted by EU strategy and regulation. Conversely, Britain has the ability to lobby and influence decisions which will impact the rest of the Union. This is evident in legislation which has been adopted, such as the *Technical Specifications for Interoperability* (OJEU, 2008), which include derogations for Britain and other Member States. EU legislation must be transposed into national law and then implemented by the Department for Transport through regulations, policies and strategies.

EU strategy documents, such as the White Paper *Roadmap to a Single European Transport Area* (European Commission, 2011a), while not legally binding, set out the future direction envisioned for the EU transport system. As such, Britain's railway system will benefit from aligning its strategies with the EU. The UK *Rail Technical Strategy*, published in 2012 (TSLG), has upwardly influenced the EU rail system, which has adopted very similar strategic themes in its own version (UIC, 2014).

## 5 Influential Strategy Documents

The structure of Britain's railway system has evolved to become vertically separated and to include many stakeholders. Consequently, there are many different decision making processes for the industry. In the following section, I describe four influential strategy documents that have been published in recent years for the railway system. Although I use the British railway system as a case study for this work, the documents studied reflect similar versions in other sectors such as healthcare, water and energy. To show this, comparisons will be drawn between each railway-specific example and equivalent documents in other sectors. For each document, I explain its background, discuss the process behind its creation, and provide an overview of the structure and content. The analysis serves as an input to the strategy design approach described in Chapter 4. Figure 11 shows the hierarchy of the four documents which have been selected.



**Figure 11 - Hierarchy of the 4 documents selected (author, 2015)**

The four documents represent a cross-section of different hierarchical levels of strategic decision making, from high level strategies to technical strategies. The Technical Specification for Interoperability is an example of the interpretation of strategy into a legally binding document and has been included for completeness.

## 5.1 2011 European Union White Paper for Transport

### 5.1.1 Introduction

The EU White Paper for transport previously referenced in this thesis (European Commission, 2011a) is an example of a strategy document produced for the European Union. The document, entitled *Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system*, puts forward the policy initiatives required of the whole EU transport system, and therefore influences Britain’s railways. White Papers which have had a comparable impact in other sectors include *Adapting to climate change: towards a European framework for action* (European Commission, 2009) and *Together for Health: A Strategic Approach for the EU* (European Commission, 2007).

### 5.1.2 Background

A White Paper is typically used to communicate proposed policies in a particular area, which may eventually become legislation. The publication of the 2011 White Paper for Transport by the European Commission (EC) is part of a general tradition to put forward a European transport strategy approximately every ten years. The 2011 edition reviews developments in the transport sector and considers the expected challenges and required policy initiatives up to 2050 (European Commission, 2011a). The publication of the strategy triggered a call for research proposals under the European Union's 7<sup>th</sup> Framework Programme, to help implement the recommendations set out in the White Paper (European Commission, 2011c), and responses to the call were required to be in line with goals set out in the paper. The development of a successful proposal therefore depended on having a clear understanding of the document. This requirement first led colleagues at the University of Birmingham to remark on the unclear and ambiguous nature of the White Paper, and to ultimately initiate the precursor to the work presented in this thesis (Mason, et al., 2012).

### 5.1.3 Process

As mentioned, when the European Commission wishes to propose new policy in a particular area, it is often communicated through a White Paper. If the initiatives proposed are received favourably by the European Council, it might eventually lead to the adoption of new EU legislation (European Commission, 2015c). Proposals can originate from a number of sources, including citizens' initiatives and public consultations. When preparing the 2011 EU White Paper for Transport, decision makers conducted Green Paper consultations, including *Towards a better integrated trans-European transport network at the service of the common transport policy* (European Commission, 2009a) and *Towards a new culture for urban mobility* (European Commission, 2007a).

The White Paper was produced by the EU Directorate General for Mobility and Transport in collaboration with Member States and European industry through agencies including the European Railway Agency and the Executive Agency for Competitiveness & Innovation



(European Commission, 2015). The document was initially drafted in English, before translation into 21 other European languages. In March 2015, the Commission launched a mid-term review of the White Paper to assess the progress made in delivering the strategy and to analyse the present situation compared with 2011 (European Commission, 2015a).

#### 5.1.4 Overview of the EU White Paper for Transport

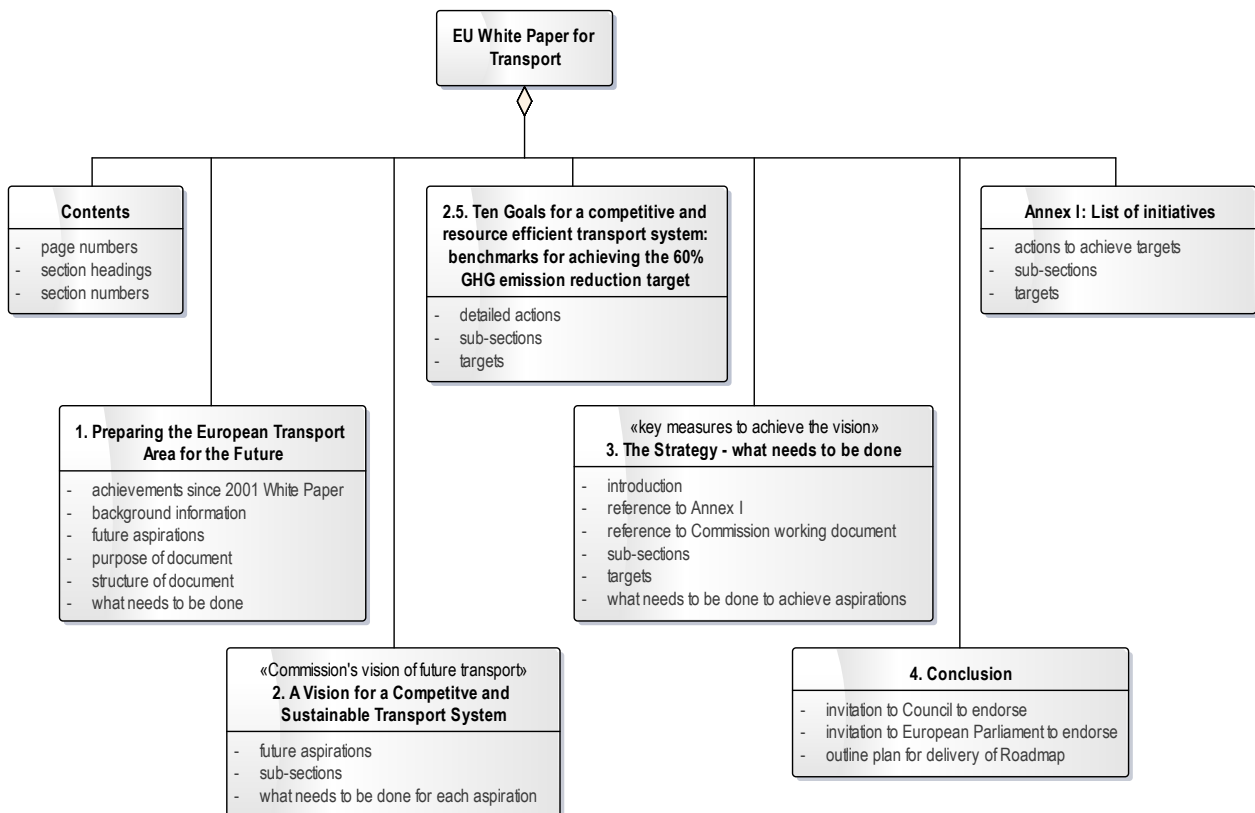


Figure 12 - Structure and content of the 2011 EU White Paper for Transport (author, 2015)

Figure 12 shows the structure and content of the EU White Paper for Transport. The document is 30 pages long and consists of four main sections and the Annex. The content is divided into paragraphs which are numbered consecutively, irrespective of the main section heading. For example, the first paragraph of section 2 is numbered 15. Each section contains a mixture of information, such as aspirations for the future of the EU transport system, what needs to be done to get there, and detailed actions to achieve specific targets. The White Paper references

an accompanying working document, which provides more detail on the key measures outlined in section 3. The text in parentheses above sections 2 and 3 in the figure is the description of each section according to information in section 1.

## 5.2 2012 Railways Act 2005 Statement (HLOS)

### 5.2.1 Introduction

The Railways Act 2005 Statement (Department for Transport, 2012) is the official national strategy for rail as set out by the Secretary of State for Transport in accordance with law. The document contains requirements for national railway activities and specifies the public funds available, therefore it has a great deal of influence on the British railway industry. Although the Statement is unique to the railway industry, similar documents exist in other sectors. For example, *The Mandate* (Department of Health, 2014) and the recent *Road Investment Strategy* (Department for Transport, 2015a) set out Government's expectations of NHS England and Highways England respectively.

### 5.2.2 Background

Britain's infrastructure manager Network Rail operates within a five year financial and planning cycle called a Control Period (CP). For each new CP, the Secretary of State sets out the requirements for Network Rail and the industry in the *Railways Act 2005 Statement* (Department for Transport, 2012). The overall Statement (commonly referred to as the HLOS) comprises the High Level Output Specification (HLOS), which details what the Secretary of State wants to be achieved, and the Statement of Funds Available (SoFA), which sets out the amount of funding likely to be available. The production of the document satisfies the requirement in the 2005 Railways Act for the Secretary of State to notify the Office of Rail and Road (ORR) about the desired outputs from the rail industry for that period, and to detail the public financial resources that are likely to be available to support this (UK Parliament, 2005).

### 5.2.3 Process

The most recent HLOS was published in 2012 for Control Period 5 from April 2014 to March 2019. The document built on the strategy set out in the Command Paper *Reforming our Railways: Putting the Customer First* (Department for Transport, 2012a). In developing the strategy, the Rail Strategy team at the DfT received input from Network Rail and industry through *Initial Industry Plans* (Network Rail, 2011) and strategies such as *Delivering the Mayor's Transport Strategy* (Transport for London, 2011). The Office for Rail and Road also contributed to the development of the HLOS in its *Advice to Ministers* (ORR, 2012), which informed the decision making in the process. Following the publication of the HLOS, Network Rail and the industry together produced *Strategic Business Plans* (Network Rail, 2013a), outlining how the required outputs will be delivered. These plans were subsequently reviewed by the ORR against the original HLOS.

### 5.2.4 Overview of the Railways Act 2005 Statement

Figure 13 shows the structure and content of the Railways Act 2005 Statement. The document is 20 pages long, comprising an introduction, the HLOS, the SoFA, and appendices. The content is divided into paragraphs, which are numbered consecutively, irrespective of the main section heading. The introduction section provides the background, context and purpose of the document. The HLOS sets out the Government's requirements in six themed areas and the SoFA details the funds available to achieve this. The appendices contain a Capacity Metric, specifying the number of passengers that must be accommodated on specific services, and an update on the progress since the 2012 Command Paper. A number of related documents are referenced.

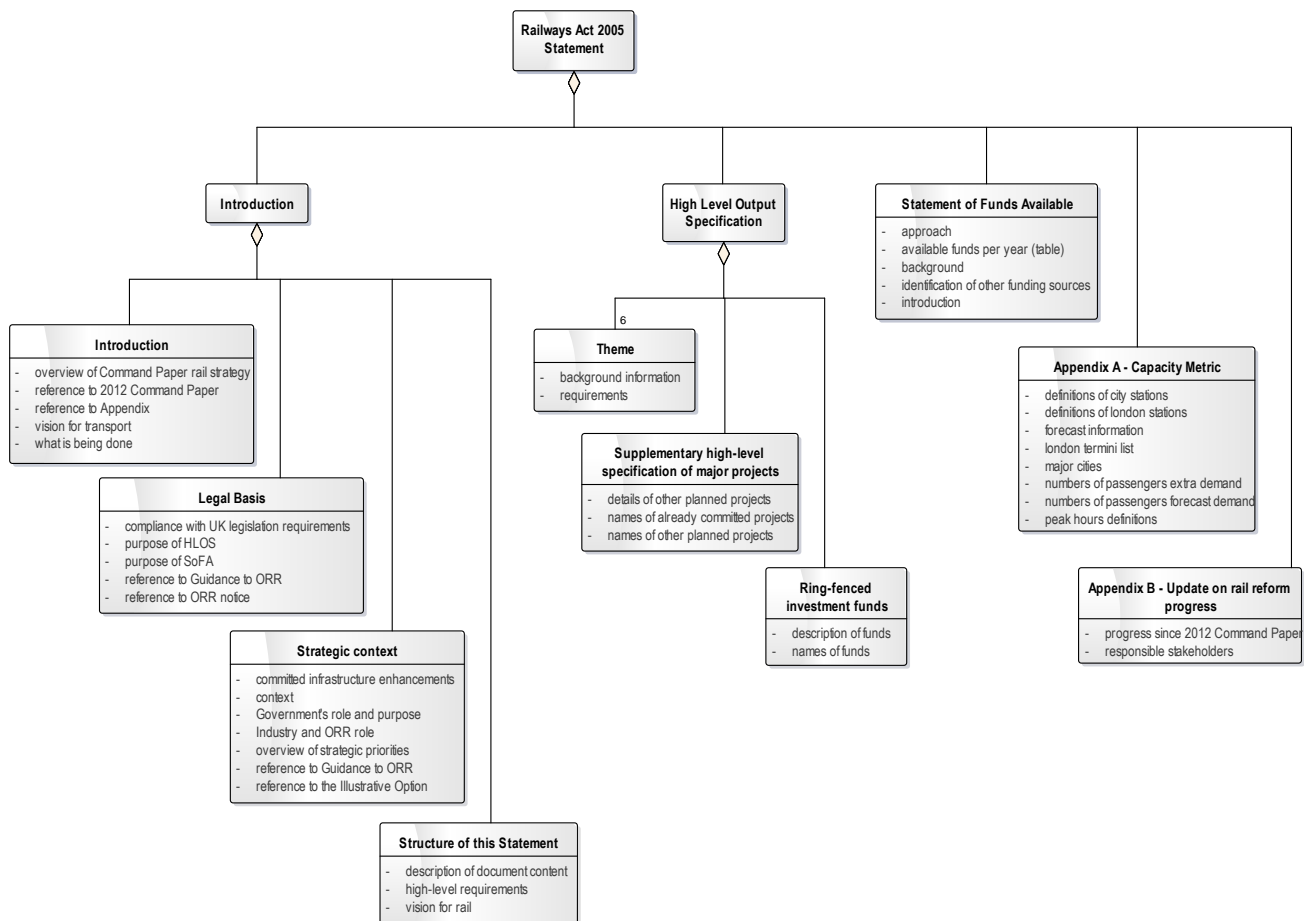


Figure 13 - Structure and content of the Railways Act 2005 Statement (author, 2015)

## 5.3 Technical Specification for Interoperability (TSI)

### 5.3.1 Introduction

The Technical Specifications for Interoperability (European Commission, 2011b) communicate requirements placed on the railway systems of EU Member States. It could be argued that TSIs have a different purpose to strategy documents, which generally communicate higher-level aspirations and intentions. However, the document provides an example of EU decisions which have had a direct, significant impact on the British railway system. Furthermore, it demonstrates how requirements (whether technical or strategic) might be communicated in a document. Similar EU standards exist in many other sectors, such as water (OJEU, 1998), communications (OJEU, 2002), and energy (OJEU, 2009).

### 5.3.2 Background

Interoperability is a European Commission initiative aimed at enabling the creation of a single European railway system, in support of the longstanding vision for a Single European Transport Area. The official Directive defines interoperability as ‘the ability of the rail system to allow the safe and uninterrupted movement of trains which accomplish the required levels of performance’ (OJEU, 2008, p. 14). The Directive sets out the essential requirements with which Member States must comply in order to ensure interoperability across the European railway system. Thus, the Technical Specifications for Interoperability (TSIs) are the set of standards that must be met in order to satisfy these requirements. In January 2012, the UK Government transposed the EC Interoperability Directive into national law, thereby obliging the UK rail system to comply with the TSIs. Specific TSIs exist for different subsystems of the railway. The *operation and traffic management* subsystem TSI has been evaluated in this work (European Commission, 2011b).

### 5.3.3 Process

TSIs are developed and drafted by the European Railway Agency (ERA) in coordination with the Railway Interoperability and Safety Committee (RISC). The Committee, which is chaired by the European Commission, comprises representatives of the Member States. RISC representatives act as a point of liaison between ERA and the governments of Member States, and proposed TSIs are communicated to Member States and discussed during RISC meetings. In Britain, RSSB is responsible for collating industry’s view on TSIs to the Department for Transport, which then provides feedback to the ERA. Votes are subsequently held to decide the specific content of each TSI. Once the Specification has been finalised, it is then subject to the *linguistic change* process, where it is translated into the other European languages.

### 5.3.4 Overview of the Technical Specification for Interoperability

Figure 14 shows the structure and content of the Operation and Traffic Management TSI, within the context of the overarching Commission Decision 2011/314/EU. The whole document is 112 pages long, of which 109 make up the TSI. The content is divided into

paragraphs, which are numbered according to the document section and sub section. Chapters 1, 2 and 3 provide an introduction to the document and the underlying legislation. Chapter 4 contains the majority of the requirements, although some are also present in other sections. Chapter 7 details the arrangements for delivering the TSI requirements. 24 appendices are attached, including a glossary, language requirements, and technical details.

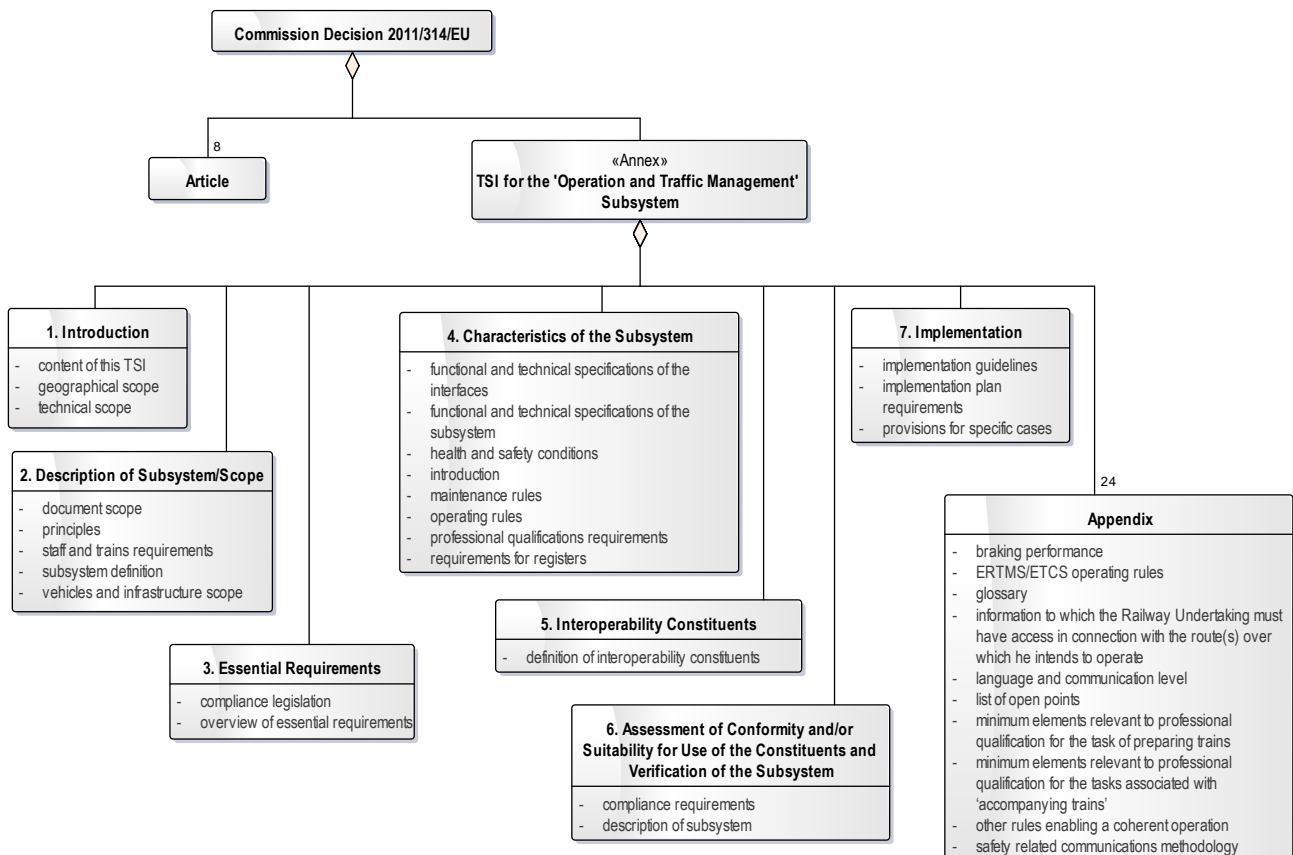


Figure 14 - Structure and content of the TSI for the Operation and Traffic Management subsystem (author, 2015)

## 5.4 2012 UK Rail Technical Strategy (RTS)

### 5.4.1 Introduction

The Rail Technical Strategy (TSLG, 2012) is an example of a collaborative strategy produced by a group of stakeholders across a sector. The document presents a shared view of the potential future benefits of new railway techniques and technologies. Collaborative strategies are also becoming increasingly common in other sectors, for example the *UK Oil and Gas*

*Industrial strategy* (HM Government, 2013) and the *Long Term Passenger Rolling Stock Strategy for the Rail Industry* (RSSSG, 2014).

#### 5.4.2 Background

The UK Rail Technical Strategy (RTS) was published in 2012 by the Technical Strategy Leadership Group (TSLG), a cross-industry expert body established by RSSB for that purpose. Unlike the earlier version of the strategy which was developed by the Department for Transport, the 2012 version was produced ‘for, and on behalf of, the rail industry in Great Britain’ (TSLG, 2012, p. 2). The strategy is intended to assist the industry’s strategic planning processes, inform policy makers and funders about the potential benefits of new techniques and technologies, and provide suppliers with guidance on the future direction of the industry (Future Railway, 2015)

The publication of the UK RTS in 2012 prompted reaction across the industry, with Network Rail producing its own version (Network Rail, 2013b) and the academic community publishing its official response (RRUKA, 2014). The European Union also set out its ‘shared perception’ of what the rail system could achieve by 2050 in the Challenge 2050 document (CER, et al., 2013). This was followed by the Rail Technical Strategy Europe (RTSE), which begins to address the contents of the vision (UIC, 2014). The themes set out in the Network Rail and European technical strategy documents closely resemble those from the original RTS, which has clearly been influential. This is an example of how a document which is perceived to be valuable can have both a downward and upward influence on related bodies and systems.

#### 5.4.3 Process

The first UK Rail Technical Strategy was delivered by the Department for Transport in 2007 in conjunction with the White Paper *Delivering a Sustainable Railway*. The cross-industry group established to deliver the strategy went on to produce the 2012 strategy in recognition of new technologies and technical processes. The new version, which is industry-owned, is considered to be more significant than its predecessor (Gaynor, 2014). The RTS 2012 was

developed by the Technical Strategy Leadership Group (TSLG), comprising industry and government representatives. The TSLG developed the initial content for the strategy, based on knowledge from domain experts, research, and extensive consultation with key industry stakeholders and academics, including workshops and written responses. Development of the strategy was a cyclical process, with content referred back to each chapter lead and re-written. The Energy chapter was drafted first, and became the template for the rest of the document. Once all the information had been gathered, a technical author ensured consistency across the document.

#### 5.4.4 Overview of the Rail Technical Strategy

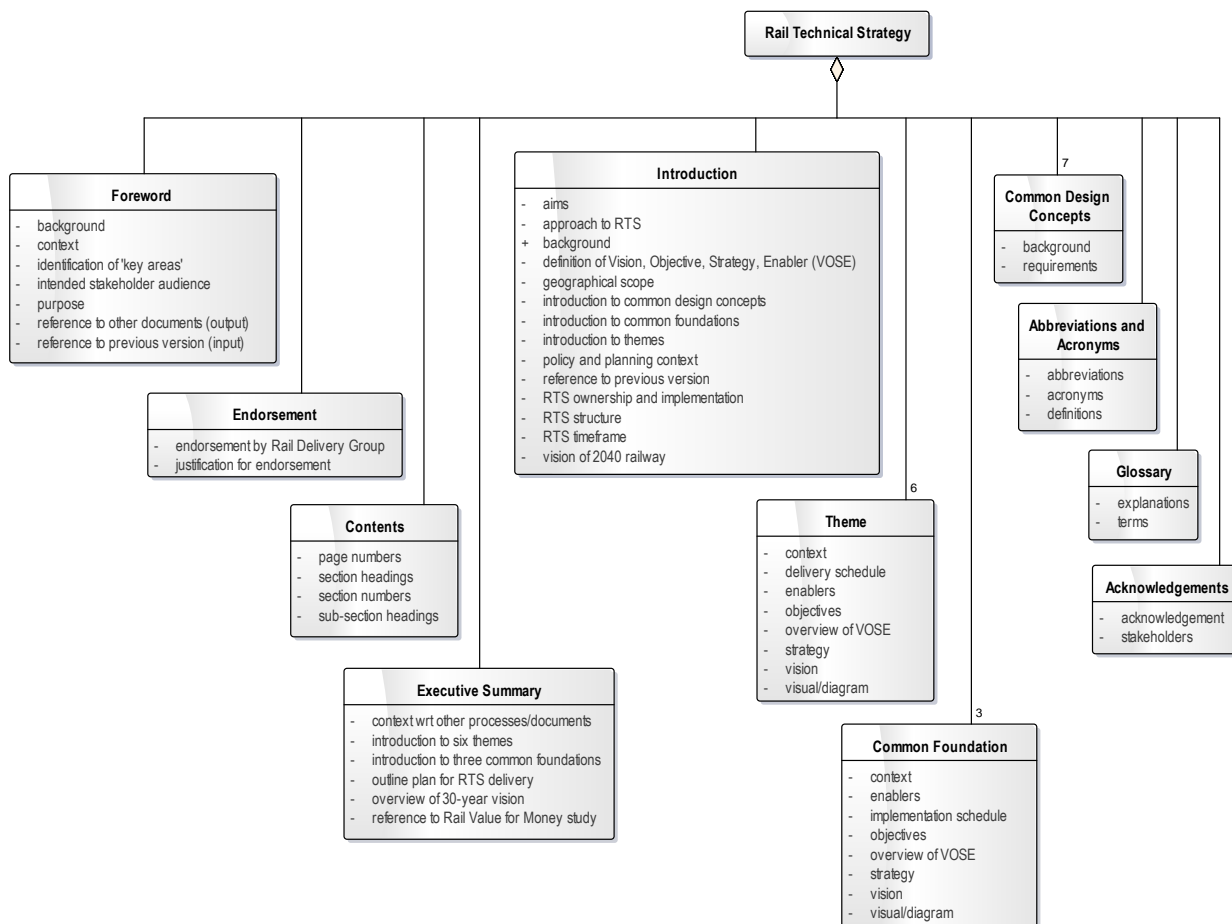


Figure 15 - Structure and content of the 2012 Rail Technical Strategy (author, 2015)



Figure 15 shows the structure and content of the 2012 Rail Technical Strategy. The document is 104 pages in length, comprising 85 pages of main content and supporting pages, such as Acknowledgements, Glossary etc. The content is divided into paragraphs, which are numbered consecutively according to the main section heading. The first five sections contain introductory and background information for the strategy. The following three sections contain the main content of the strategy, divided into six Themes, three Common Foundations and seven Common Design Concepts. The document is completed with a glossary, abbreviations and acknowledgments.

## 5.5 Comparison of the Documents

The four documents studied have different purposes and are intended for different audiences. The processes followed in designing each strategy were tailored according to each scenario. Although the documents included some common information, such as requirements, they generally vary in style, structure and content, as shown in the overview figure of each document.<sup>2</sup> Some documents, such as the Rail Technical Strategy, include a detailed introduction, whereas others immediately commence with strategy decisions, for example the White Paper.<sup>3</sup> The examination of these documents demonstrates that variety exists in the way which strategic decisions are captured and communicated. These factors have been taken into account in determining the requirements for the strategy design approach. The four documents described here are further evaluated in Chapter 4.

## 6 Summary

The original military model of communicating strategic decisions is based on dissemination through a downward chain of command. However, in today's increasingly complex, multi-stakeholder sectors, a different approach is necessary. Complexity in decision making is especially evident in the European Union (EU), where legislation and strategy impacts each

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<sup>2</sup> The approach shall allow flexibility in the structure and style of the strategy document

<sup>3</sup> The approach shall specify information to be included in the strategy document

individual Member State. Following many structural reforms, Britain's railway offers an example on the challenges of designing and delivering strategy for complex, vertically separated systems. Decision making for the system is shared between UK and EU Governments, the infrastructure manager, operators, and collaborative efforts. In this chapter, I have provided examples of four influential documents which communicate strategy for the British rail system.

The EU White Paper for Transport is an example of a strategy document which has been produced for the European Union. Similar documents exist in other sectors, including energy and healthcare. The Railways Act 2005 Statement, which is comparable to documents produced for the Highways Agency and NHS England, contains requirements set by the Government. The Technical Specifications for Interoperability (European Commission, 2011b) communicate the legal requirements placed on the railway systems of EU Member States. Similar EU standards exist in many other sectors, including water, communications, and energy. Finally, the Rail Technical Strategy (TSLG, 2012) is an example of a collaborative strategy produced by a group of stakeholders across a sector. Similar examples are evident in the UK oil and gas and rolling stock industries. In the following chapter, the four documents will be evaluated for quality and usability, then assessed for alignment with systems engineering principles.

# CHAPTER 4

## STRATEGY DOCUMENTS EVALUATION

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### 1 Introduction

In the previous chapters, I have established that there is no universally adopted approach to designing strategy. For Britain's railway system, strategies are developed by different groups of stakeholders following the approach that suits their respective needs. Consequently, documents produced to communicate those strategies vary in content, style and structure, as evident in the four example documents studied in Chapter 3. In order to gauge general perception of these documents, I organised an informal workshop with a group of individuals. The results are set out below. In the second part of this chapter, the same documents are evaluated for alignment with systems engineering principles. The first exercise serves to demonstrate the need for a formalised approach, while the second shows areas for potential alignment of strategy design with systems thinking.

### 2 User Workshop

The user workshop was designed to provide an indicative evaluation of the quality and usability of the four sample documents by a group of individuals. The exercise was not intended to be a rigorous analysis, but to add more substance to existing anecdotal opinion on the documents.

#### 2.1 Approach

##### 2.1.1 Participants

The workshop was held as part of the Systems Engineering module of the MSc programme in Railway Systems Engineering and Integration at the University of Birmingham. Participants on the course have a range of professional backgrounds – from train operating companies to consultancies and government departments. They are likely to assume roles on major railway

projects in future and be asked to capture requirements from similar documents to those evaluated. The diversity of the group ensured that different opinions were taken into account for evaluating the documents and obtaining input to the approach. A total of 39 participants took part in the trial.

### 2.1.2 Structure

Workshop sessions took place for two hours per day over four days at the University of Birmingham. Participants were divided into small groups with a mixture of experience and nationalities. Each group was asked to identify and elicit requirements from extracts of the four documents evaluated above. At the end of the week, the groups presented their work and each participant undertook an individual survey assignment.

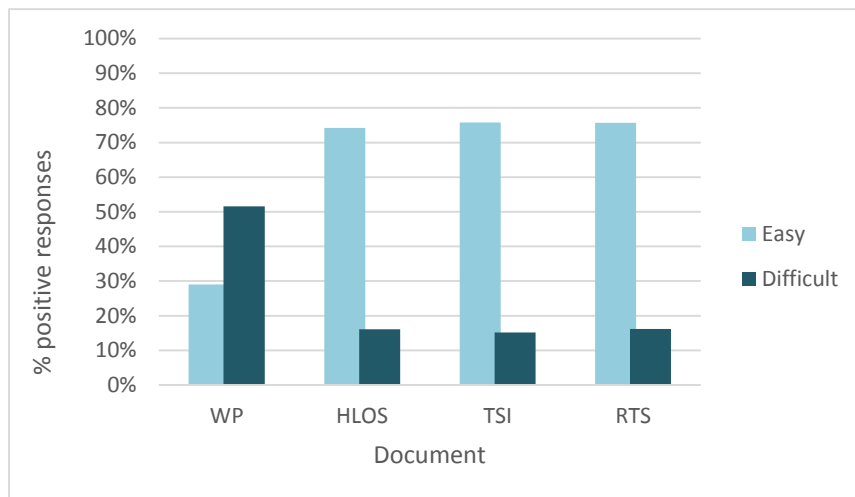
### 2.1.3 The Survey

The survey contained a mixture of questions on the approach taken to the task, the usefulness of the source documents, and the ease of the exercise. For each document provided as a requirements source, the participants were asked whether they mostly agreed or mostly disagreed with a number of statements. Certain questions were asked in two different ways in order to reduce the impact of language barriers. In the case of conflicting responses, the answer was not taken into account in the findings. For example, if a participant mostly agreed that the document was both 'easy to understand' and 'difficult to understand', this answer was not taken into account. A second series of questions asked the participants to choose which of the four documents most corresponded to a particular statement. Only one response per statement was allowed. There were also two free text questions, where feedback and further insights could be provided. A full copy of the survey questions is included in the Appendix.

## 2.2 Results

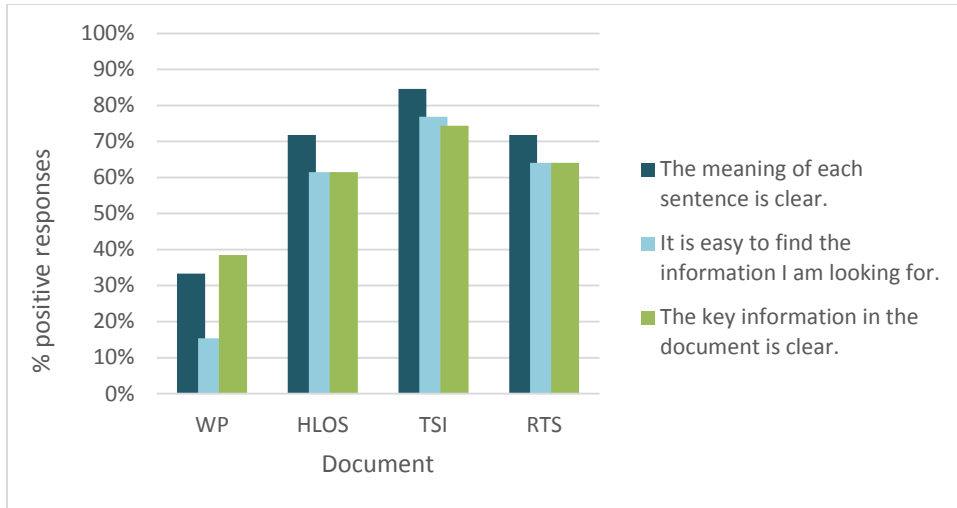
### 2.2.1 Ease of Understanding

Participants were asked how well they had understood each document, first on an individual basis (Figure 16 and Figure 17) and then as a direct comparison against the other documents (Figure 18).



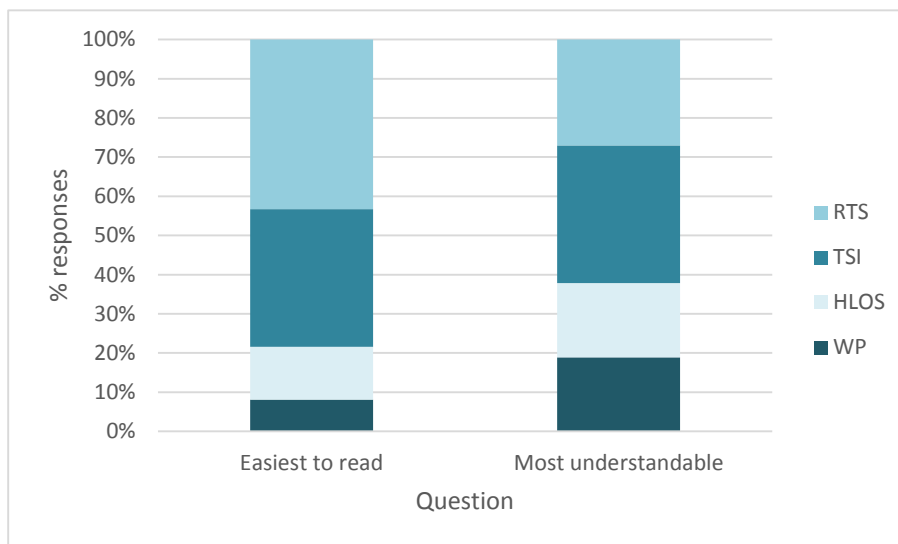
**Figure 16 - % of responses agreeing that each document was 'easy' or 'difficult' to understand**

The results showed a common feeling among respondents that the EU White Paper for transport is not very accessible, with 51.6% agreeing that it is difficult to understand (Figure 16). The other three documents received similar scores to each other, with over 70% of participants finding the documents easy to understand. Participants generally found information in the HLOS, TSI and RTS to be clear and easy to find, with each document scoring over 60% in this area (Figure 17). The EU White Paper, however, scored less than 40% for each of these questions, with only 15.4% finding it easy to find important information in the document. The highest scoring document was again the TSI, with the HLOS and RTS rated very similarly.



**Figure 17 - % of responses agreeing with each statement**

When choosing the document which best matched certain statements (Figure 18), respondents generally found the Rail Technical Strategy and the Technical Specification for Interoperability to be the easiest to read (43.2% and 35.1%) and the most understandable (35.1% and 27%).<sup>1</sup>



**Figure 18 - Documents found to be the easiest to read and the most understandable**

<sup>1</sup> The approach shall facilitate effective communication

### 2.2.2 Quality

When asked about the quality of the documents (Figure 19), respondents tended to agree that the TSI and RTS were well written, with less than 20% feeling that they were poorly written. Opinion was more divided on the HLOS and EU White Paper, with just over 50% of respondents agreeing. For the HLOS, a high proportion of respondents (21.6%) felt that the document was neither written well nor poorly.

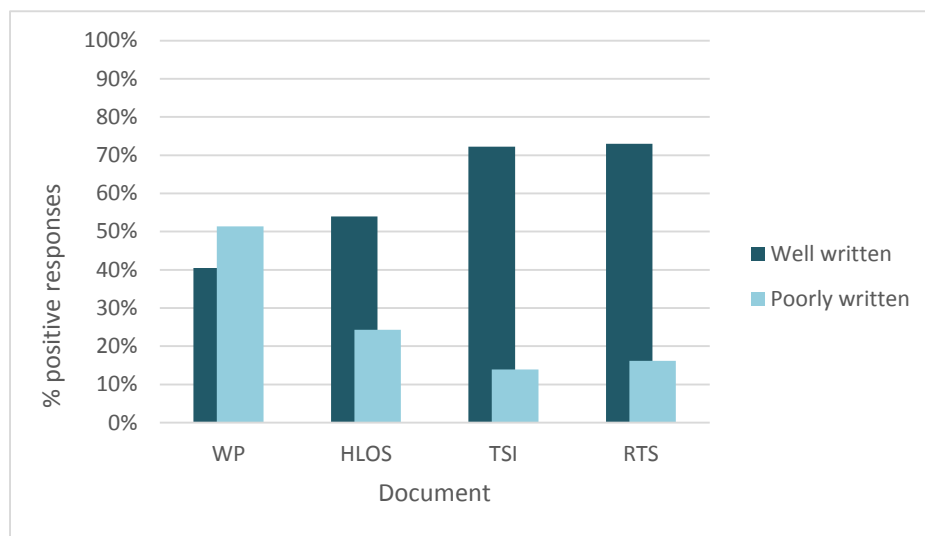
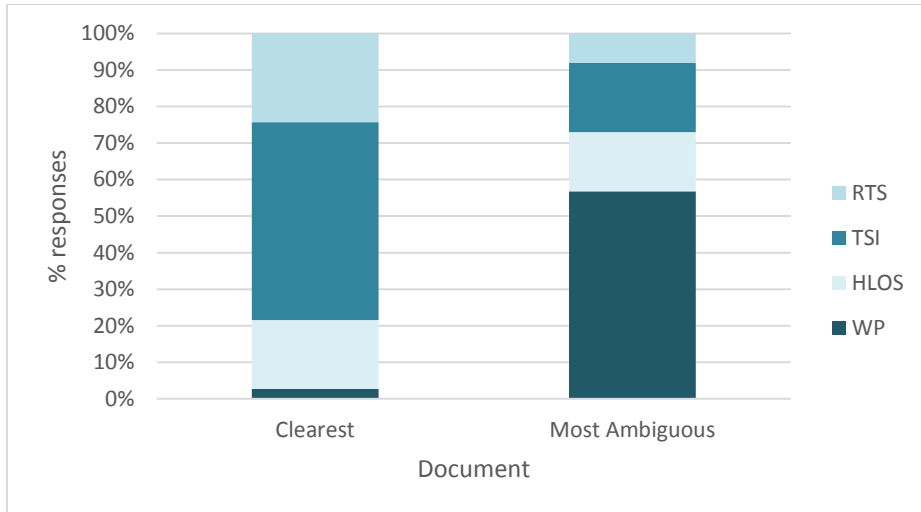


Figure 19 - % of responses agreeing that the document was 'well written' or 'poorly written'

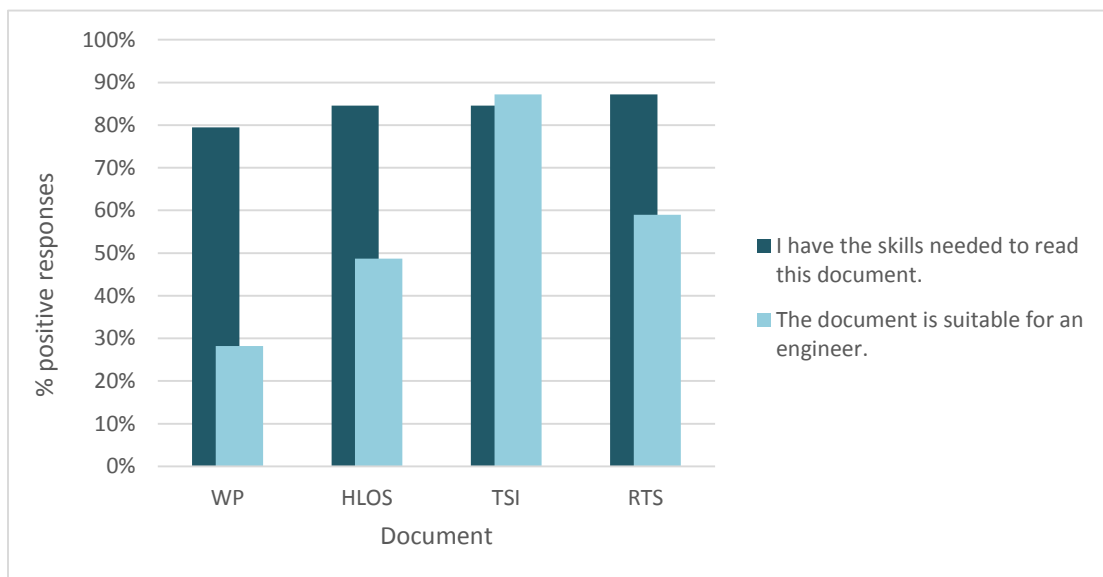
Respondents again tended to reach a common agreement on which document was the clearest and the most ambiguous (Figure 20). 54.1% of participants found the TSI to be the clearest document, followed by the RTS then the HLOS. Only 2.7% thought that the White Paper was the clearest, with over half also finding the document to be the most ambiguous.



**Figure 20 - Documents considered to be the clearest or the most ambiguous**

### 2.2.3 Suitability

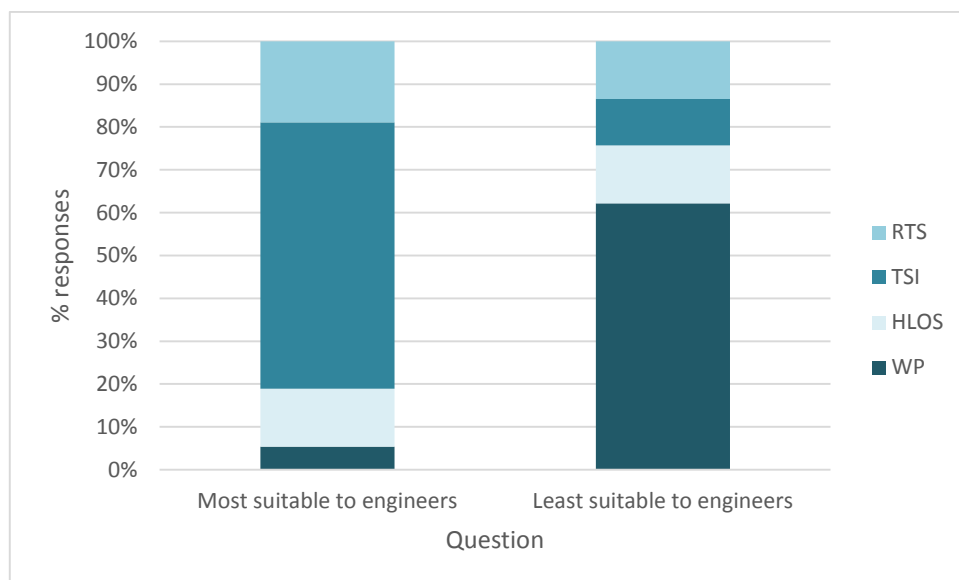
Participants were also asked about the type of audience which the documents might suit (Figure 21 and Figure 22).



**Figure 21 - % of responses agreeing with statements on suitability**



Interestingly, a high percentage of the respondents felt that they had the necessary skills to read each document (Figure 21), despite having stated that some of the documents were unclear and difficult to understand. This discrepancy could be explained by the fact that the workshop was part of an assessed Masters course, which is designed to improve the skill level of the participants. Therefore, respondents may have felt disinclined to admit a lack of skill in a particular area, even though in this context it would not have been a poor reflection of their ability, but rather of the quality of the documents. Alternatively, it might suggest that although the participants found the activity difficult, they were still able to use their skills to complete the task effectively.



**Figure 22 - Documents considered to be the most and least suitable to engineers**

There was a strong consensus among the participants that the White Paper was not suitable for an engineering audience (Figure 22). Over 60% of the responses stated that it was the least suitable document and only 5.4% chose it as the most suitable. The document voted the most suitable for engineers, by a distinct margin, was the TSI with 62.2%. This result reflects the fact that the four documents studied have different purposes and are intended for different

audiences.<sup>2</sup> However, interestingly, 100% of the participants identified at least one requirement in every document. Even if the White Paper was not written for or designed to be read by engineers, it nevertheless contains requirements that may ultimately shape engineering projects or research proposals in future. Therefore, it might be more appropriate to produce several different perspectives of the strategy information according to the intended audience. Furthermore, from personal experience, documents which do contain detailed requirements for projects can be written in a style which is closer to the White Paper than the structured and precise TSI.

#### 2.2.4 Free Responses

Participants were asked to provide two freely written responses about the approach taken to carry out the team exercise and any extra information. Although most of the answers principally gave feedback on the exercise, some added extra valuable information to this study. The complete version of the free responses is included in the Appendix.

#### **Perspective**

Several respondents commented that the answers to the questions were completely dependent on perspective – for example, one person’s perception of a well-written document may differ to someone else. This is a valid point which highlights the challenge of communicating effectively to a varied audience. Several groups had chosen to review the identified requirements together, after having initially captured them individually. This suggests that participants felt that the potential requirements were open to interpretation and not exact. One group used two people to scan each document, before reviewing the set together ‘to determine if the requirement was actually a requirement’ (Respondent 6). One respondent said that differences in interpreting the requirements led to unexpected inconsistencies (Respondent 17). These comments were also reflected in the variety of the requirements identified by different groups working on the same project. This feedback highlights the

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<sup>2</sup> The approach shall allow for different methods of communication for different audiences

subjective nature of natural language and supports the case for using additional tools such as model based approaches (Evans, et al., 2013).

## **Comprehension**

A number of responses also drew attention to the difficulty of the task for non-native English speakers, as participants were required to ‘read between the lines’ to gather true meaning in places (Respondent 15). Some respondents found the documents to be ambiguous (Respondent 1), vague (Respondent 21), complex and difficult to understand (Respondent 29). However, the exercise was also recognised as reflecting the real world of work, where documents can be full of ‘Euro-speak’ and ‘political language’ (Respondent 15). Real-life railway projects are likely to be carried out by multinational teams, and it is important that communication issues do not hinder progress or introduce risk. In particular, requirements must be presented in a clear and unambiguous way, whether in an official requirements document or a strategy document.<sup>3</sup>

## **Requirements Identification**

Requirements were generally identified in the documents by looking for sentences using instructive verbs such as *need*, *should* and *must*. One respondent described the requirements as ‘subtle’ and another said that certain requirements which initially appeared to be unrelated were later revealed to have ‘systematic links’ to others (Reference 28). Another participant felt that in some cases, the requirements were so subtle that they could be missed (Respondent 10).

## **2.3 Discussion**

The user workshop provided valuable insight into how the four sample documents are generally perceived in terms of quality and usability. The EU White Paper, which is a high level

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<sup>3</sup> The approach shall specify the use of clear language, including the definition of terminology

strategy document, was considered by many to be ambiguous and difficult to understand. By contrast, the TSI, which is a lower-level legal specification, was largely regarded to be clear and well-written. These results are somewhat unsurprising, as it is recognised that the documents have different purposes and are intended for different audiences. However, although the workshop participants represented a range of roles from engineers to civil servants, perceptions of each document were very similar. The majority of respondents, even those who may eventually work in government organisations, found the White Paper to be difficult to understand. The potential implication of this, as discussed in section 4.5, is miscommunication, misalignment with strategic decisions, and the associated risks. In the following section, I introduce principles from the systems engineering domain which I believe could alleviate those risks when translated to strategy design.

### 3 Systems Engineering Alignment

In the systems engineering domain, considerable effort is made to understand and accurately capture a client's needs, and to communicate this information to those who will deliver the solution. In strategy design, however, efforts are typically focussed on making the right strategic decisions, with effective communication sometimes undervalued. I attempt to bridge the gap between effective decision making and successful delivery by proposing an approach to strategy design which is aligned with systems engineering principles. In the following part of this chapter, I describe how the Systems Engineering Competencies Framework has been used in this work to establish nine overarching SE principles that inform the strategy design approach. Each principle is described from a systems engineering perspective and subsequently interpreted in the context of strategy design. The tool is then used to evaluate how well the four example documents currently align with SE principles, and identify where there is potential for improvement.

#### 3.1 Systems Engineering Principles

Systems engineering is focussed on understanding, managing and developing complex systems (INCOSE UK, 2004). This requires the interpretation of varied information, the clear

definition of customer needs, and the communication of those needs to the people responsible for delivery. As such, there are discernible similarities with strategy design, which is the interpretation of information to make strategic decisions, followed by the onward communication of those decisions. Strategy designers face similar communication challenges as systems engineers in expressing and disseminating future needs. Systems engineering, therefore, can offer potentially valuable experience to the field of strategy design.

### 3.2 INCOSE Systems Engineering Competencies Framework

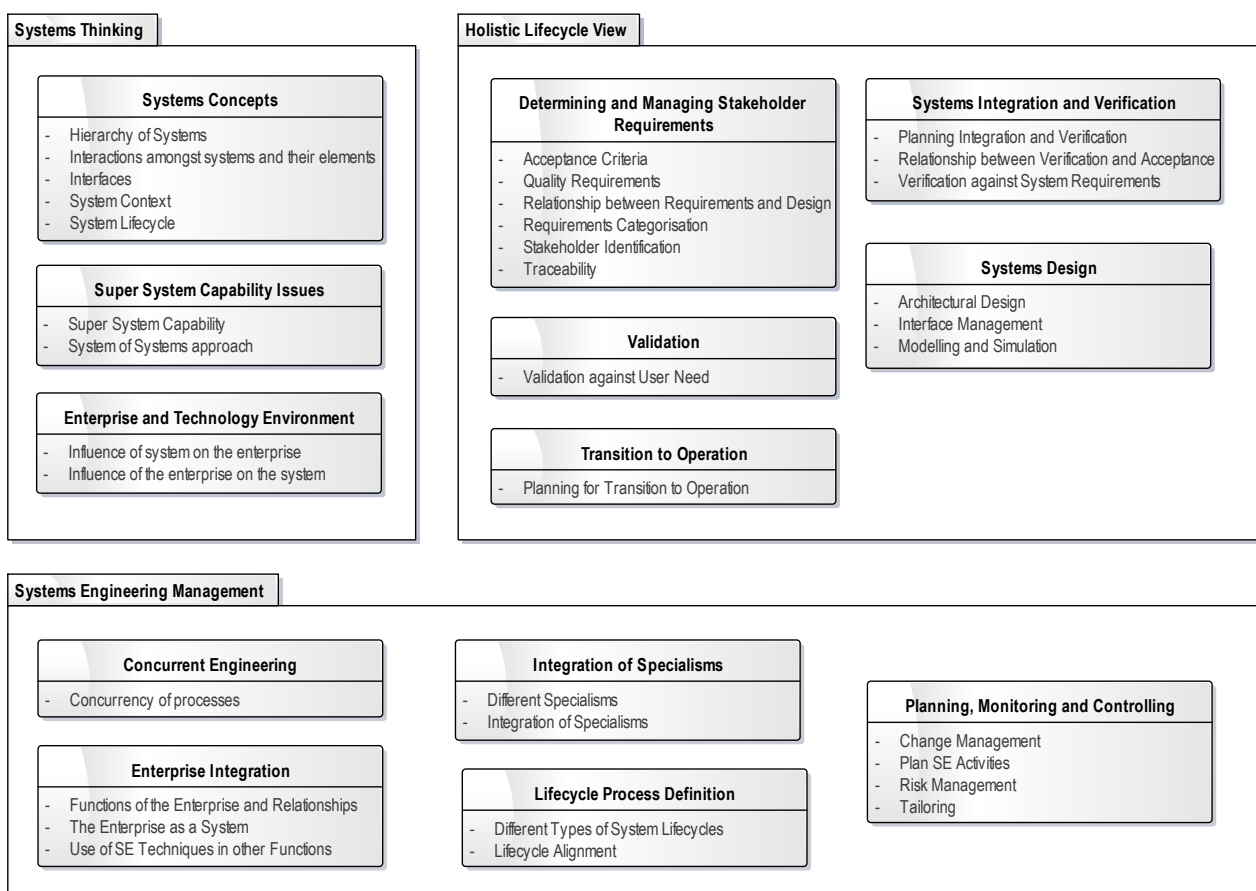


Figure 23 - Overview of the INCOSE Systems Engineering Competencies Framework (author, 2015)

The INCOSE Systems Engineering Competencies Framework was developed to provide a ‘common language’ for describing and discussing the competencies required to conduct good systems engineering (INCOSE UK, 2010). The Framework is intended to be used for measuring how well a person or organisation performs SE. For the purpose of this work, it

provides a detailed set of SE practices as defined by the official systems engineering body. Figure 23 shows an overview of the competencies described in the Framework.

Thirteen overall competencies are identified in the Framework, divided into the themes of *Systems Thinking*, *Holistic Lifecycle View* and *Systems Engineering Management*. For each competency, a number of associated concepts are described. In Figure 23, the concepts considered to be applicable to strategy design are listed underneath each competency. For simplicity, I have assembled these concepts into nine overarching *principles*, which are listed in Table 1.

**Table 1 - The nine SE principles mapped against the SE Competencies Framework**

SE Concepts (INCOSE UK, 2010)	Principle Name (author, 2015)
Planning Integration and Verification Concurrency of Processes Change Management Plan SE Activities Risk Management Tailoring Planning for Transition to Operation	Planning
System Lifecycle Different Types of System Lifecycles Lifecycle Alignment	Lifecycle
Hierarchy of Systems System Context Interactions amongst systems Functions of the Enterprise and Relationships The Enterprise as a System	Context
Super System <sup>I</sup> Capability System of Systems approach Influence of the Enterprise <sup>II</sup> on the System Influence of the System on the Enterprise Stakeholder Identification	Understanding the Problem

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<sup>I</sup> The Framework uses the term *super system* to describe ‘the level above the system of interest’ (INCOSE UK, 2010). In the context of this research, I have chosen the term *system of systems* to signify the same concept.

<sup>II</sup> The term enterprise is used in the Framework to signify an entity ‘supportinga defined business scope and mission that includes interdependent resources [...] that must coordinate their functions and share information in support of a common mission’ (INCOSE UK, 2010).

Interfaces Interactions amongst System Elements Architectural Design Different Specialisms	Decomposition & Integration
Requirements Categorisation Acceptance Criteria Relationship between Requirements and Design	Requirements Definition
Traceability Interface Management Integration of Specialisms	Traceability
Verification against System Requirements Relationship between Verification and Acceptance Validation against User Need	Verification & Validation
Modelling and Simulation Use of SE Techniques in other Functions Quality Requirements	Language

The nine overarching SE principles which I have identified in Table 1 are elaborated below. First, the meaning of each principle is described in a systems engineering context, based on the INCOSE Competencies Framework. Subsequently, each principle is considered from the perspective of designing strategy. Since the published output of a strategy design exercise is often a strategy document, examples of how each principle might be manifest in a strategy document are provided. These examples are not exhaustive.

### 3.3 The Principles

#### I. Planning

**Systems Engineering:** In a systems engineering context, planning is the tailoring of generic processes to establish a systems engineering plan. It is important for identifying systems engineering needs and coordinating SE activities. Planning includes the identification, assessment, analysis and control of systems engineering risks. Effective planning enables the tracking of progress, thereby allowing for appropriate corrective actions to be identified and taken if the project or programme performance deviates from the plan. The Framework declares that ‘the alternative to planning is chaos’ (INCOSE UK, 2010).

**Application in Strategy Design:** In the context of strategy design, planning translates as the tailoring of generic processes to establish a strategy design plan. This includes the identification of strategy design needs and the coordination of relevant activities. Effective planning will allow corrective actions to be identified and taken if the strategy design exercise deviates from the plan.

**Evidence in Strategy Documents:**

- Referencing planning activities (e.g., consultation exercises)
- Referencing decision making tools and techniques
- Including a plan for delivering the strategy

## II. Lifecycle

**Systems Engineering:** The systems lifecycle is considered to cover the whole life of a system, from the identification of needs and requirements to the operation and ultimate disposal of the system. In systems engineering, the lifecycle forms the basis of planning projects or programmes. Selecting an appropriate lifecycle and aligning it with related lifecycles is critical to the development of a successful system. (INCOSE UK, 2010) The lifecycle can be represented using various different models, such as the v model (Figure 7) or the Ring model (Figure 8).

**Application in Strategy Design:** In the context of strategy design, the lifecycle would refer to the whole life of a strategy, from understanding the purpose of the exercise, to publishing and eventually withdrawing or replacing the strategy.

**Evidence in Strategy Documents:**

- Stating a timescale for the strategy (e.g., a 30 year vision)
- Providing historical context
- Specifying details about future iterations of the strategy
- Stating the expected validity of the strategy



- Suggesting a time plan for delivery
- Referencing the lifecycles of other strategies

### III. Context

**Systems Engineering:** Central to systems thinking is gaining an understanding of how decisions and actions in one area can affect others. This implies appreciating the system within the context of its wider environment (socially, politically, financially, culturally, academically, etc.) It includes understanding where the boundaries of the system lie (scope) and how the system interacts with other related systems (interfaces). From an SE viewpoint, a system is only considered successful if it meets the needs of its wider system of systems. In order to understand the complete set of requirements of the system, it must therefore be fully appreciated in its context.

**Application in Strategy Design:** From the perspective of strategy design, context refers to how the strategy is related to its wider environment. This includes considering the scope of the strategy and examining its interrelationships with other strategies. The strategy for a particular organisation might only be deemed successful if it is aligned with the needs of its wider environment.

#### **Evidence in Strategy Documents:**

- Illustrating the strategy within its environment and system of systems
- Naming related strategies
- Identifying interfaces with other strategies
- Describing the purpose or goals of the overall system of systems
- Identifying stakeholders with an interest in the strategy
- Describing the scope of the strategy

#### IV. Understanding the Problem

**Systems Engineering:** Understanding the problem is one of the first activities in the systems engineering lifecycle. A problem statement defines what the system must deliver. Appreciating the context and lifecycle of a system helps to consider the problem being addressed, and vice versa. This principle also includes identifying stakeholders and understanding the requirements of the system of systems.

**Application in Strategy Design:** In the context of strategy design, understanding the problem includes why the strategy is being designed, how it will be used, and the expectations of stakeholders.

#### **Evidence in Strategy Documents:**

- Explaining the reason for designing the strategy
- Stating the expectations of stakeholders
- Describing the purpose of the strategy
- Referencing the needs of the system of systems

#### V. Requirements Definition

**Systems Engineering:** Requirements describe the problem that is being addressed by the development of a system, including the expectations of relevant stakeholders. Determining and managing stakeholder requirements is a specific competency in the INCOSE Framework, which includes eliciting, defining and analysing requirements. Requirements definition is the capture of requirements into a format that can be used by a project (usually in written language, but sometimes as a model). Although there is no universal approach for managing the requirements of a project, there is general agreement on what constitutes a ‘good quality’ requirement. For example, it should be a singular, concise, measurable statement which avoids unnecessarily constraining the design.

**Application in Strategy Design:** Strategy documents set out what needs to be achieved in order to meet a particular goal (i.e. the requirements of relevant stakeholders). The systems engineering standards for writing requirements are therefore equally applicable in the context of strategy design.

**Evidence in Strategy Documents:**

- Requirements are clearly identifiable
- Requirements are concise
- Where feasible, requirements are measurable
- The unnecessary specification of solutions is avoided

VI. Decomposition & Integration

**Systems Engineering:** When designing a system, the systems engineering approach focusses on understanding the functionality required of that system. For example, one of the required functions of a train is to transport people or goods from A to B. Functional decomposition refers to the breaking down of the higher level functions of a system to lower levels, in order to select components. Integration is then the logical process by which the individual components of a system are assembled to make the whole. A decomposition exercise must be carefully planned, considering the identified context and interfaces, in order to aid successful integration.

**Application in Strategy Design:** In a strategy design context, decomposition and integration relate to the appropriate partitioning of the strategy for the purpose of the design exercise, and the subsequent integration of the areas into a whole strategy.

**Evidence in Strategy Documents:**

- Partitioning the strategy into functional areas (e.g., Communications, People, etc.)
- Breaking down aspirations and needs into further detail
- Categorising aspirations and needs according to functional area

- Demonstrating how the individual areas form the whole strategy
- Linking overall needs and aspirations to those in individual areas

## VII. Traceability

**Systems Engineering:** The principle of traceability is critical throughout the systems engineering lifecycle. It refers to the explicit linking of key information to its source and to any related information. For example, a requirement should be traceable to its source (stakeholder, document etc.), to any justification which is available (called *rationale*), and to any lower-level requirements which are derived from it. If full traceability is maintained, it should be possible to trace an individual component of the system back to the originating high level requirement. Traceability assists with designing and integrating the system, and assessing the impact of change throughout the lifecycle.

**Application in Strategy Design:** Traceability can equally be applied in strategy design to link key information explicitly to its source and to other related information.

### **Evidence in Strategy Documents:**

- Linking aspirations to background information (rationale)
- Linking needs to the related aspiration
- Linking high level and low level needs
- Linking overall aspirations and needs to those in individual areas

## VIII. Verification & Validation

**Systems Engineering:** Verification and validation (v&v) are specific processes in the systems engineering domain, and there is much debate regarding their respective meanings. For the purpose of this work, verification will be understood as the determination of whether a process has been carried out correctly. Validation is concerned with establishing whether the output of the process satisfies the original need. By these interpretations, verification is related to the *process*, whereas validation corresponds to the final *output*.

**Application in Strategy Design:** In the context of strategy design, verification is used to determine how well the strategy design *process* has been carried out, whereas validation establishes if the final strategy fulfils the intended purpose. It is difficult to determine from a strategy document alone how well the strategy design process has been carried out (verification). However, some indicators might be evident.

**Evidence in Strategy Documents:**

- The strategy fulfils the stated purpose
- Measures of success are suggested for strategy delivery
- The strategy includes all the information specified in the relevant process or template

IX. Language

**Systems Engineering:** The principle of language is important throughout the systems engineering lifecycle. The early stages of system design depend on understanding and capturing the customer's needs accurately, then clearly documenting and communicating the resulting requirements. Modelling is commonly used in the systems engineering domain alongside natural language to aid understanding, demonstrate complexity and improve communication. Establishing a consistent language framework early in the system design improves the quality of understanding throughout the lifecycle.

**Application in Strategy Design:** From a strategy design perspective, language is equally critical. Successful strategy delivery depends on the effective communication of decisions in the strategy. Establishing a consistent language framework early in strategy design will improve the quality of understanding throughout the strategy lifecycle.

**Evidence in Strategy Documents:**

- Clearly stating aspirations and needs
- Providing a glossary of key terms
- Using consistent terminology

- Organising information to facilitate navigation
- Using modelling techniques where appropriate

### 3.4 Summary

In this section, I have consulted the INCOSE Competencies Framework to identify systems engineering principles which could be applied to a strategy design exercise. From the thirteen SE competencies listed, I have distinguished nine overarching SE principles: Planning, Lifecycle, Context, Understanding the Problem, Requirements Definition, Decomposition & Integration, Traceability, Verification & Validation, and Language. I have described each competency from a systems engineering perspective and suggested how it might be manifested in a strategy design exercise. In the following section, the nine SE principles are used to evaluate the strategy documents described in Chapter 3.

## 4 Evaluation of Existing Strategy Documents

In this work, I propose aligning strategy design with the systems engineering principles identified above. In order to identify potential areas of alignment, I first needed to establish whether current approaches are already aligned in any respect. To do this, I evaluated the four sample strategy documents against the nine principles identified above. The exercise served three purposes:

- Identifying evidence of alignment between systems engineering and strategy design
- Highlighting areas of potential further alignment between strategy design and SE
- Providing a comparative evaluation of the four documents from an SE perspective

### 4.1 Scoring

The four example documents were evaluated against the SE principles using an indicative scoring system. The 3-point approach reflects commonly used performance monitoring techniques, such as the RAG (Red/Amber/Green) rating system (Cabinet Office, 2015) and the Italian Flag method (Blockley & Godfrey, 2000), enabling a general indication of SE behaviour

and a broad comparison of the four documents. Where there was reasonable evidence of alignment with an SE principle, a score of 2 was given. Where evidence of alignment with a principle was limited, a score of 1 was given. Finally, where there was no evidence of alignment, a score of 0 was given. The results are based solely on evidence available in each strategy document. For example, a strategy only scored well for Planning if reference to planning activities had been made in the document. The evaluation demonstrated the potential to use the INCOSE SE Competencies Framework to identify systems engineering behaviour in other non-traditional domains.

## 4.2 Results

The results from the four evaluations are presented below.

### 4.2.1 EU White Paper for Transport

The EU White Paper for Transport scored 5 points out of a possible 18 on the evaluation, showing limited alignment with systems engineering principles. While it is recognised that the document is not intended for an engineering audience, principles such as Language and Understanding the Problem are beneficial to any audience and therefore should be considered when designing strategy. As explained in Chapter 1, this is based on the assumption that the purpose of a strategy is explicitly stated, and does not take into account implicit motivations, such as influence. It is recognised that other principles, such as Lifecycle and Traceability, are traditionally more applicable in an engineering environment. However, the purpose of this work is to highlight the possible benefits of translating these ideas to the non-traditional domain of strategy design. Therefore, a low score on this evaluation shows that there are many potential areas of SE alignment. The detailed justification of the scoring for the EU White Paper is shown in Table 2.

**Table 2 - EU White Paper scores for alignment with SE principles**

Document: EU White Paper for Transport		
Principle	Score	Justification
<b>Planning</b> Deciding and stating how the strategy will be designed.	0	There is no information about how the strategy was developed.
<b>Lifecycle</b> The whole life of the strategy, from understanding the purpose of the exercise, to publishing and eventually withdrawing or replacing the strategy.	1	The timeline of the strategy is until 2050, although this is not immediately clear. No information is provided on the next expected iteration, although the previous version is referenced.
<b>Context</b> How the strategy is related to its wider environment	1	The White Paper does refer to other strategies, such as Europe 2020, but this information is not obvious and appears in section 2. The overall goals of the European Union are referenced, but the scope of the strategy is not clearly defined.
<b>Understanding the Problem</b> Why the strategy is being designed and the expectations of stakeholders.	0	There is no explanation of why the strategy has been developed. A very brief description of the document's purpose does not appear until paragraph 14.
<b>Requirements Definition</b> The quality of the requirements included in the strategy.	1	The document is presented as a series of numbered paragraphs, each containing lots of information and multiple requirements. The paragraphs are dense, and the quality of the requirements is poor (e.g. expressing requirements in the negative form and presenting several requirements in one statement).
<b>Decomposition &amp; Integration</b> The appropriate partitioning of the strategy and the subsequent integration of the individual areas into a whole strategy.	1	Some attempt has been made to divide the document into sections. However, there is no clear link between the information. Section 2 is divided into four overall aims and section 3 contains four main themes, but they are not obviously linked. Information relating to rail, air, sea and roads is mixed together. The initiatives section is divided into 40 headings, but the division of the content is linear.
<b>Traceability</b> The explicit linking of key information in the strategy.	0	There has been no attempt at ensuring traceability in the document. The detailed initiatives at the end of the document are not traced back to any of the goals or rationale described earlier in the text. It would be very difficult to estimate the impact of not carrying out one of the initiatives on the whole strategy.
<b>Verification &amp; Validation</b> Determining how well the strategy design process has been carried out and whether the final strategy fulfils the intended purpose.	1	Many of the initiatives are vague and not testable (e.g. 'take appropriate steps'). However, in some places this is more tangible (e.g. 'develop a framework').



<b>Language</b> Establishing a consistent language framework.	0	The paper does not include a glossary of key terms. Words such as <i>benchmark</i> , <i>action</i> , <i>goal</i> and <i>target</i> are used without definition, sometimes interchangeably. The section headings are vague and do not clearly explain the content.
<b>Total</b>	<b>5/18</b>	

#### 4.2.2 Railways Act Statement 2005

The Railways Act 2005 Statement scored 8 out of 18 possible points on the evaluation, showing some alignment with systems engineering principles. This result reflects the fact that the document is a high level strategy which also contains specific requirements. However, there are again many potential areas of alignment, including Requirements Definition, which scored very poorly. The detailed justification of the scoring for the document is shown in Table 3.

**Table 3 – High Level Output Specification scores for alignment with SE principles**

Document: Railways Act 2005 Statement		
Principle	Score	Justification
<b>Planning</b> Deciding and stating how the strategy will be designed.	2	It is explained that the document is published regularly in line with legal requirements. Some information on how the strategy and figures were established is included in the Appendix (for example, forecasting). There is also some detail about how the document should be implemented.
<b>Lifecycle</b> The whole life of the strategy, from understanding the purpose of the exercise, to publishing and eventually withdrawing or replacing the strategy.	1	The lifecycle of the strategy is described to be 5 years, and the SoFA includes spending for this period. Some historical context is also provided.
<b>Context</b> How the strategy is related to its wider environment	1	The context of the strategy is set out and reference is made to some related documents (for example the Command Paper).
<b>Understanding the Problem</b> Why the strategy is being designed and the expectations of stakeholders.	1	The scope of the document is explained, although this doesn't appear until paragraph 12 and is not explicitly called such. The purpose of the document is described, but this is also not immediately clear due to the lack of headings.
<b>Requirements Definition</b> The quality of the requirements included in the strategy.	0	There are many requirements present in the body of the document, although these are buried in dense paragraphs of text. Several requirements are frequently presented as one single statement.

<b>Decomposition &amp; Integration</b> The appropriate partitioning of the strategy and the subsequent integration of the individual areas into a whole strategy.	1	The HLOS is divided into eight main themes (e.g. Capacity and Safety). There is no overall view of how the strategy has been decomposed and therefore how each section fits together.
<b>Traceability</b> The explicit linking of key information in the strategy.	0	There has been no attempt to link the requirements in the document to each other or to the rationale. Different information types are presented in the same paragraph.
<b>Verification &amp; Validation</b> Determining how well the strategy design process has been carried out and whether the final strategy fulfils the intended purpose.	1	The document includes poor measures of success for the requirements (for example, 'reduce the risk of accidents at level crossings') The purpose of the document has been explained.
<b>Language</b> Establishing a consistent language framework.	1	There is no overall glossary, but some concepts and terms are defined in the footnotes. The paragraphs are continuous and linear, with no headings.
<b>Total</b>	<b>8/18</b>	

#### 4.2.3 Technical Specification for Interoperability

The TSI scored 15 points out of a possible 18, showing good alignment with systems engineering principles. This result was expected, as the user evaluation showed that participants found this document to be the most suitable for an engineering audience. As a standard, the TSI has a legal power to compel, therefore the language must be more exact than a high level strategy. Likewise, it may not be deemed necessary to provide a detailed context of the document, as this may exist elsewhere. This result shows how a document which is well aligned with SE principles might appear, although the proposed approach will be tailorable for any hierarchical level of strategy. The detailed justification of the scoring for the TSI is shown in Table 4.

**Table 4 – Technical Specification for Interoperability scores for alignment with SE principles**

Document: Technical Specification for Interoperability		
Principle	Score	Justification
<b>Planning</b> Deciding and stating how the strategy will be designed.	1	Some information is included regarding the legislative processes which were followed in compiling the TSI. The document calls upon each Member State to develop its own implementation plan.
<b>Lifecycle</b> The whole life of the strategy, from understanding the purpose of the exercise, to publishing and eventually withdrawing or replacing the strategy.	2	The historical context of the document is provided. Member States are required to develop their implementation plan within a specific time frame. Reference is made to older documents that are repealed with the publication of this version.
<b>Context</b> How the strategy is related to its wider environment	1	Reference is made to related legislative and source documents. The scope of the TSI is described, but there is minimal contextual information.
<b>Understanding the Problem</b> Why the strategy is being designed and the expectations of stakeholders.	2	Some reasoning behind developing the document is given. The aim of the document is explained in detail.
<b>Requirements Definition</b> The quality of the requirements included in the strategy.	2	The requirements are written in a uniform manner, using 'must' statements. Each requirement is written on a new line of the document and given a unique number with the theme.
<b>Decomposition &amp; Integration</b> The appropriate partitioning of the strategy and the subsequent integration of the individual areas into a whole strategy.	2	The requirements are categorised by the characteristics of the subsystem, for example health & safety. There is no overall view of how the different characteristics of the subsystem are related. However, general requirements of the system and interface requirements have been included.
<b>Traceability</b> The explicit linking of key information in the strategy.	1	The requirements are presented as a list of individual statements and no rationale is given.
<b>Verification &amp; Validation</b> Determining how well the strategy design process has been carried out and whether the final strategy fulfils the intended purpose.	2	The purpose of the document is clearly stated. Information on how verification against the document should be carried out and some measures of compliance are provided.
<b>Language</b> Establishing a consistent language framework.	2	Consistent terminology is used and informative headings are included. A glossary of terms is also provided.
<b>Total</b>	<b>15/18</b>	

#### 4.2.4 UK Rail Technical Strategy

The UK Rail Technical Strategy scored 12 out of a possible 18 points, showing reasonable alignment with some systems engineering principles. This result shows that it is feasible to

apply some SE principles to documents which are designed for a varied, public audience. The Rail Technical Strategy has been read by a range of individuals, from engineers to academics and politicians. The document also scored well in the user evaluation, generally being perceived as clear and easy to understand. The detailed justification of the scoring for the Rail Technical Strategy is shown in Table 5.

**Table 5 – Rail Technical Strategy scores for alignment with SE principles**

Document: Rail Technical Strategy		
Principle	Score	Justification
<b>Planning</b> Deciding and stating how the strategy will be designed.	2	Information about the different stakeholders involved in developing the strategy is included. Some detail about how strategic decisions were made is provided (such as using assumptions from the Network Rail Route Utilisation Strategy). The 2010 consultation on the strategy is mentioned and some information on implementation plans is included.
<b>Lifecycle</b> The whole life of the strategy, from understanding the purpose of the exercise, to publishing and eventually withdrawing or replacing the strategy.	2	The historical context of the documents is provided, with reference to the earlier 2007 version. A detailed timeline for implementation is included within each theme.
<b>Context</b> How the strategy is related to its wider environment	2	The strategy references a number of related documents (such as the EU White Paper and the Rail Value for Money study). The geographical scope and the policy, planning and historical contexts are clearly stated. Reference is made to the overall vision and strategy of the European Union.
<b>Understanding the Problem</b> Why the strategy is being designed and the expectations of stakeholders.	2	The background, aims and scope of the documents are described and clearly signposted.
<b>Requirements Definition</b> The quality of the requirements included in the strategy.	0	Many requirements are evident in the strategy and enablers sections of the themes. However, they tend to be written in a dense paragraph of text and several requirements are combined in one statement.
<b>Decomposition &amp; Integration</b> The appropriate partitioning of the strategy and the subsequent integration of the individual areas into a whole strategy.	1	The strategy is divided into six themes, three common foundations and seven common design concepts. The strategy refers to whole-system issues such as reliability and maintenance. However, it does not show how the individual themes (e.g. Infrastructure and Energy) are related in the whole picture.

<b>Traceability</b> The explicit linking of key information in the strategy.	0	Visions, objectives, strategies and enablers are presented in a linear format without any explicit linking between the information. It is therefore difficult to determine which enablers correspond to which strategy, and which objective is being addressed.
<b>Verification &amp; Validation</b> Determining how well the strategy design process has been carried out and whether the final strategy fulfils the intended purpose.	1	Some measures of success have been included on the implementation time plans. The purpose of the strategy is clearly explained.
<b>Language</b> Establishing a consistent language framework.	2	Definitions of the key terms vision, objectives, strategy and enablers are given and a glossary has been included.
<b>Total</b>	<b>12/18</b>	

#### 4.2.5 Overall

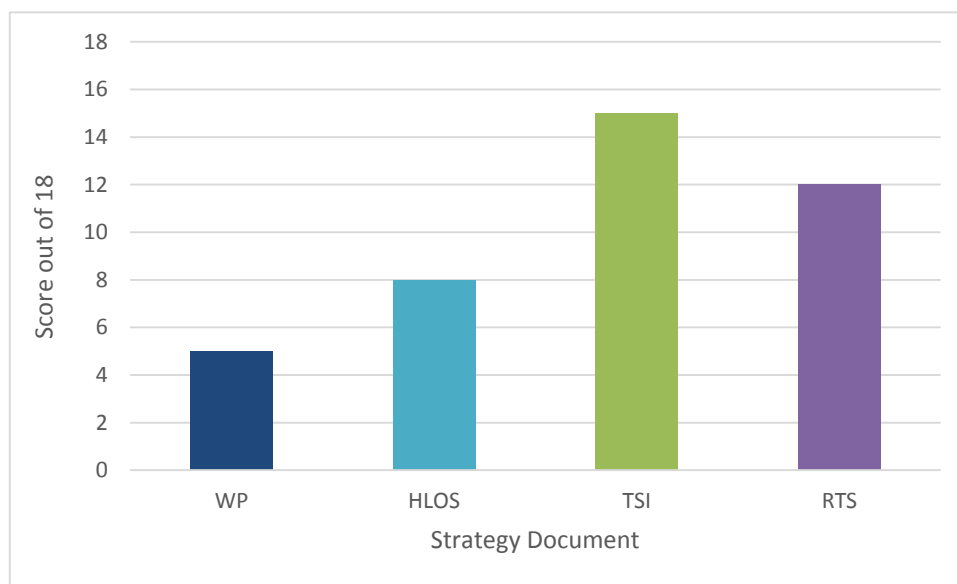


Figure 24 - Comparison of overall systems engineering alignment for the 4 documents

The results of the four evaluations showed varying alignment with systems engineering principles across the documents studied, from very limited to good alignment. The EU White Paper scored poorly, with only 5 points, whereas the Technical Specification for Interoperability scored 15 out of 18. The High Level Output Specification also scored relatively poorly, with less than half of the possible marks, but the Rail Technical Strategy fared better,

scoring 2/3 of the marks. These results do not suggest that all strategy documents should resemble the TSI, which is a technical standard with legal implications. It does, however, show that there is potential for further alignment across all the documents. It also demonstrates that the Rail Technical Strategy, which scored well on the user evaluation, displays systems thinking in a number of areas.

#### 4.2.6 Principles

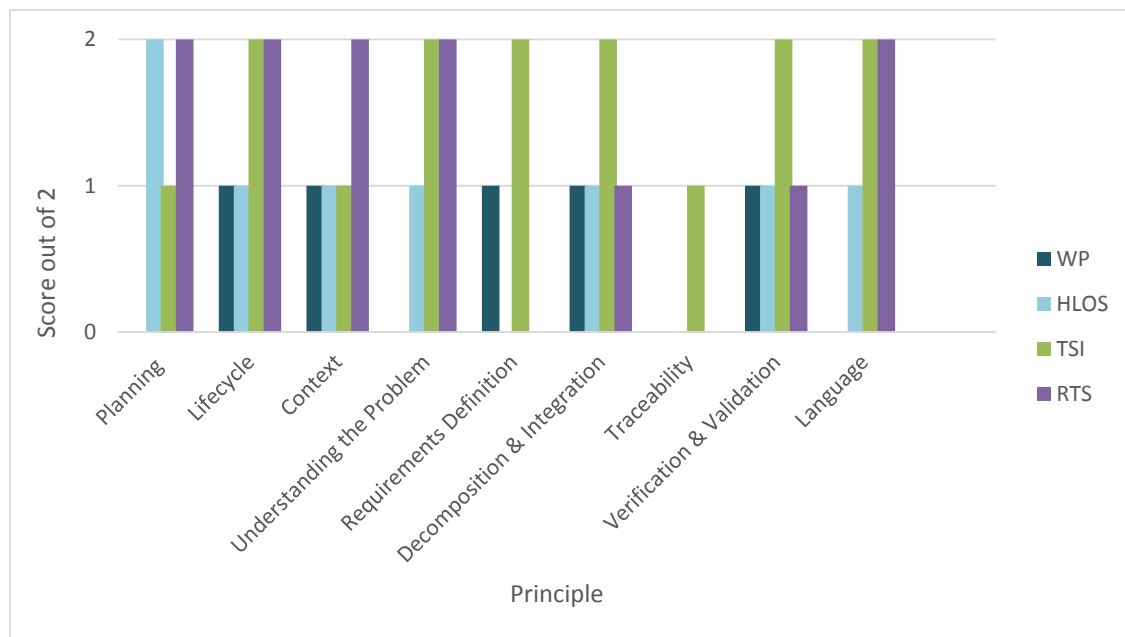


Figure 25 - Comparison of SE principles alignment for the 4 documents

In general, the documents demonstrated a reasonable consideration of the planning aspects of strategy development, although the EU White Paper showed no evidence of this. All of the documents scored poorly on tracing information to its source and related information. Likewise, most of the documents did not provide an overview of how the individual parts of the strategy were integrated together. With the exception of the TSI, the documents also failed to provide ‘good quality’ requirements as understood in the SE domain. All of the principles will be translated into the strategy design approach. Although some of the documents scored

reasonably well in the evaluation, the results show that there is limited consistency in the design of strategy. This reinforces the need for a more formalised approach and appropriate guidance for those designing strategy.

## 5 Comparing the Evaluations

Evaluating the four influential strategy documents against the Systems Engineering Competency Framework illustrated some alignment with systems engineering principles. The Technical Specification for Interoperability scored well on the evaluation, whereas the EU White Paper for Transport showed limited alignment with SE practice. Results from the user evaluation of the four documents showed that most people found the Rail Technical Strategy and the TSI to be clear and well communicated, whereas the EU White Paper and the Railways Act 2005 Statement were experienced as ambiguous and difficult to understand. Similar feedback was received when students were asked about the quality of the documents and their suitability for engineers. For interest, I compared the scores from the two separate evaluation exercises, as shown in Figure 26.

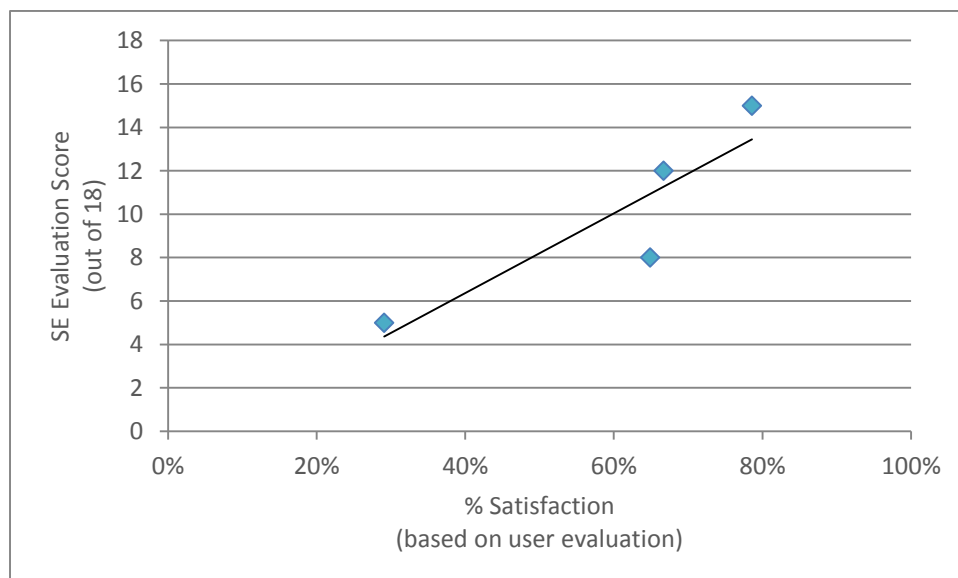


Figure 26 - Correlation between SE alignment and user satisfaction

Although the comparison provides only an indication, it suggests a general correlation between alignment with SE principles and user perception of the documents. The EU White Paper for transport, which showed limited alignment with systems engineering, was considered to be unclear and difficult to use. The TSI, however, which showed many examples of SE good practice, was generally well-received by the user group. This trend suggests that applying basic SE principles to the design of strategy could have a noticeable positive impact on its communication.<sup>4</sup> In turn, this might increase the success of strategy delivery and reduce risk to major investments. In the following chapter, I will suggest an approach for applying these systems engineering principles in the context of strategy design.

## 6 Requirements for the Strategy Design Approach

As indicated in Chapter 1, in line with systems engineering practice, I have established a set of requirements against which the strategy design approach will be evaluated. The requirements, which can be traced to the footnotes in each chapter, were captured from the literature review, the railway system case study, and evaluations of current approach. They are shown below. The reference number relates to the chapter and the footnote. For example, 3.3 is found in footnote 3 of Chapter 3.

### **Requirements identified in the literature review (Chapter 2)**

- 2.1. The approach shall allow for a strategy to be communicated using natural language and modelling techniques.
- 2.2. The approach shall use the terminology defined in this work.
- 2.3. Communication shall be considered during strategy design.
- 2.4. The approach shall be generic (suitable for any audience).
- 2.5. The approach shall consider all activities associated with strategy (not solely decision making).
- 2.6. The approach shall include guidance for communicating strategy.
- 2.7. The approach shall demonstrate systems thinking.

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<sup>4</sup> The approach shall be aligned with systems engineering principles



### Requirements identified from the railway industry case study (Chapter 3)

- 3.1. The approach shall provide guidance for producing a strategy document.
- 3.2. The approach shall allow flexibility in the structure and style of the strategy document.
- 3.3. The approach shall specify information to be included in the strategy document.

### Requirements identified by evaluating current approaches (Chapter 4)

- 4.1. The approach shall facilitate effective communication.
- 4.2. The approach shall allow for different methods of communication for different audiences.
- 4.3. The approach shall specify the use of clear language, including the definition of terminology.
- 4.4. The approach shall be aligned with systems engineering principles.

## 6.1 Requirements Set

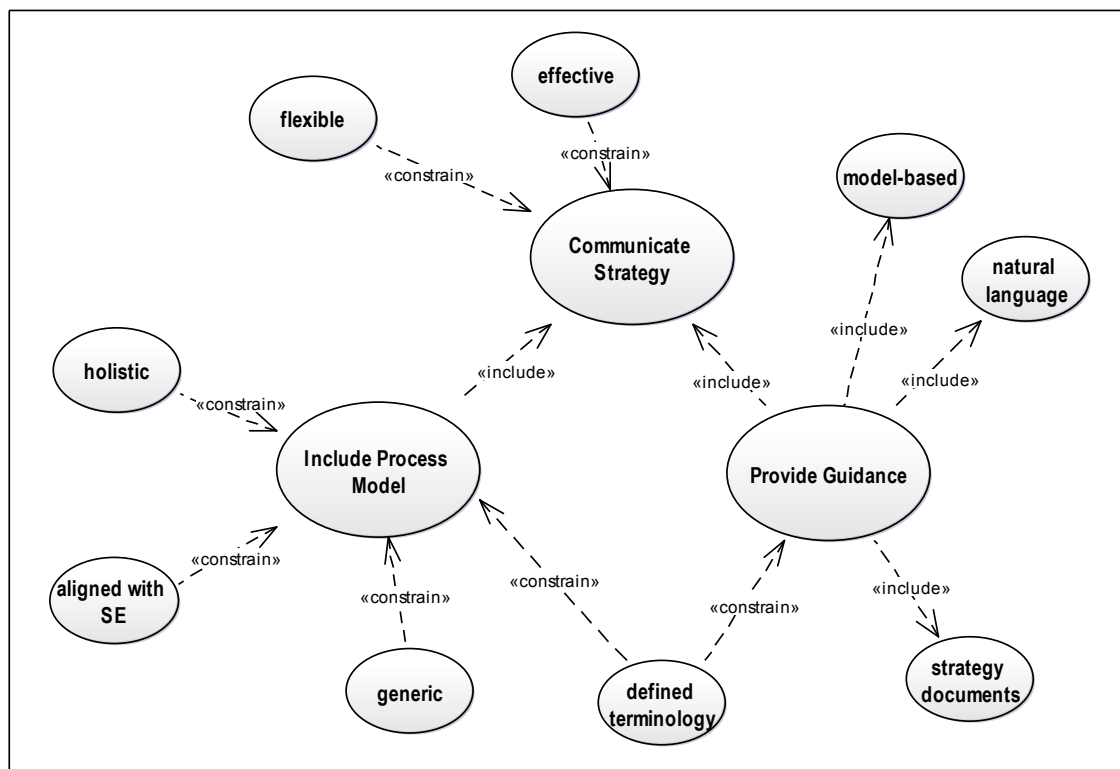


Figure 27 - Requirements set for the Strategy Design approach (author, 2015)

It is clear that some of the requirements captured are similar or related to others. Therefore, I have amalgamated the requirements above into a single use case diagram (Figure 27), which is a commonly-used requirements modelling technique. The requirements are described textually in Table 6 below.

**Table 6 - Requirements set for the strategy design approach**

Approach Requirement #	Text	Derived from (Chapter.footnote)
RA1	The approach shall include a process model.	2.2, 2.4, 2.7, 4.1, 4.4
RA1.1	The process model shall be generic.	2.4, 3.2, 4.2
RA1.2	The process model shall be holistic.	2.5, 2.7
RA1.3	The process model shall be aligned with systems engineering principles.	4.3, 4.4.
RA1.4	The process model shall apply the defined terminology.	2.2, 4.3
RA2	The approach shall include strategy communication.	2.3
RA2.1	The approach shall support effective communication.	3.3, 4.1, 4.3
RA2.2	The approach shall support the use of any communication tool.	2.1, 4.2
RA3	The approach shall include guidance.	2.6
RA3.1	The guidance shall use the defined terminology.	2.2, 4.3
RA3.2	The guidance shall reference model-based communication.	2.1, 2.6
RA3.3	The guidance shall reference natural language communication.	2.1, 2.6
RA3.4	The guidance shall cover how to produce a strategy document.	3.1, 3.2, 3.3

The requirements identified here will be used to inform the modelling technique selection and the approach development in Chapter 5.

# CHAPTER 5

## A MODEL FOR STRATEGY DESIGN

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### 1 Introduction

Discussions in previous chapters have shown that although some existing strategy design approaches are reasonably aligned with systems engineering practice, it is not commonplace. This was illustrated by the difference in scores when evaluating railway strategy documents against the INCOSE Competency Framework in Chapter 4. A user evaluation of the documents indicated common perspectives on the quality and usability of each document. There was a general correlation between alignment with SE principles and user perception of the documents. Taking these results into account, I defined a set of requirements for the strategy design approach proposed in this work. The present chapter provides a description and justification of the modelling technique applied in developing the approach. The strategy design model is then presented through the seven views specified by the framework. Detailed guidance for the approach and an example case study are included in the appendices.

### 2 Processes

The word *process*, like *strategy* and *system*, has historically been defined in many ways. Madison (2005) describes a process simply as ‘a group of activities that leads to some output or result’. Holt (2005) provides a more thorough explanation of a process as ‘an approach to doing something that consists of a number of activities, each of which will produce or use information. Each of these activities is the responsibility of a single stakeholder’. Both interpretations consider a process, such as strategy design, to comprise a number of activities which together produce an output, in this case, a strategy. The words *process* and *approach* are often used interchangeably, as evidenced in Holt’s definition above. The Process Structure view in this chapter (Figure 30) illustrates the slight distinction made between the two concepts for the purpose of this work.

### 3 Process Modelling

Processes have long been regarded as a key contributor to the success of a business or organisation (Davis, 2001). Business Process Modelling (BPM) emerged out of a need to understand such processes in order to improve them, thereby improving the business (Williams, 1967). Today, process modelling is considered to be a valuable tool in the systems engineering domain (Osmundson, et al., 2004). It constitutes ‘the documentation, analysis and design of the structure of business processes, their relationships with the resources needed to implement them and the environment in which they will be used’ (Davis, 2001). Perry (2006) adds that process modelling must ensure the capture of both the behavioural and structural aspects of a process.

#### 3.1 Techniques

Many techniques have been proposed to assist with process modelling exercises. In a review of existing methods, Aguilar-Saven (2004) identifies nine frequently used techniques for modelling processes. Brownsword (2009) evaluates ten such techniques, whereas Johansson et al. (2012) focus on four that are widely used to describe problematic and complex situations in organisations. Five of the most commonly used techniques are described below.

##### 3.1.1 Flowchart

The flowchart was one of the earliest developed process modelling techniques (Gilbreth, 1921) and is still in common use today. The graphical technique depicts the order of activities in a process through boxes and connecting arrows. The flowchart notation is defined by international standard 5807:1985 (ISO, 1985) on information processing. Aguilar-Saven (2004) credits the technique for its communication ability and ease of use, but describes it as being too flexible. The flowchart performs poorly in the evaluation against Moody’s quality criterion (Johansson, et al., 2012).

### 3.1.2 IDEF

IDEF (Integrated DEFinition) is a family of modelling methods commonly used in the software and systems engineering domains. Each method within the IDEF family has been developed for a particular application, such as information modelling (IDEF1) or organisation modelling (IDEF12). The IDEF methods associated with process modelling are IDEF0 for function modelling, IDEF3 for capturing process descriptions, and IDEF5 for ontology description capture. The technique is recognised for its strengths, such as the provision of strict rules (Aguilar-Saven, 2004), but lacks the ability to provide a formal output (Brownsword, 2009) or represent roles (Aguilar-Saven, 2004).

### 3.1.3 UML

The UML (Unified Modelling Language) is a general modelling notation designed for a broad range of modelling applications (OMG, 2015). The UML comprises 14 diagrams representing either structural or behavioural information. The *activity* diagram is commonly associated with process modelling for its ability to represent the order of activities in a process (Aguilar-Saven, 2004) (Johansson, et al., 2012). However, other UML diagrams such as the *use case* and *class* equally offer process modelling functionality (Perry, 2006) (Brownsword, 2009). The UML has been adopted as an ISO standard (ISO 19501) and is mandated for certain applications by the UK Government (Cabinet Office, 2004).

### 3.1.4 BPMN

The BPMN (Business Process Model and Notation) were developed to provide a standard process modelling notation suitable to all process users across a business (OMG, 2011). The BPMN initiative aims to consolidate best practices from existing notations, including the UML and IDEF. The notation comprises symbols which are comparable to the flowchart technique and the UML activity diagram, focussing on the behavioural aspects of a process. The BPMN technique is considered by some to be the best option for modelling business processes (Johansson, et al., 2012). However, others highlight weaknesses in the approach, including its

inability to model the structural aspects (Brownsword, 2009) or the requirements of a process (Perry, 2006).

### 3.1.5 SysML

The Systems Modelling Language (SysML) is an extension of a subset of the UML which has been developed specifically for systems engineering applications (OMG, 2012). The SysML comprises 7 of the UML diagrams, with some modifications, and two new diagram types. The language is supported by prominent systems engineering tools, including Sparx Enterprise Architect, Windows Visio and IBM Rhapsody (OMG, 2015a).

## 3.2 Technique Selection

When choosing a process modelling technique, a number of factors should be carefully considered, including the purpose of the modelling exercise (Phalp, 1998). In the context of this work, a process modelling technique is required for defining and communicating a common approach for strategy design. To choose an appropriate technique for this purpose, the following requirements were derived from the approach requirements established in Chapter 4 and the process modelling definitions examined above.

**Table 7 - Process modelling technique requirements**

#	Requirement	Rationale	Derivation
RT1	The technique shall enable the modelling of a strategy design approach, including:	The technique must be applicable to the purpose of the modelling exercise.	(Phalp, 1998) RA1
RT1.1	process requirements	Understanding the requirements for the process will help to ensure that the needs of stakeholders are met.	(INCOSE UK, 2004) RA1.3
RT1.2	process information	Process modelling should capture the structural aspects of a process. Information modelling can aid understanding and effective communication.	(Perry, 2006) RA1.2 RA1.4
RT1.3	process activities	Process modelling should capture the behavioural aspects of a process. The process activities will form the basis of the user guidance.	(Perry, 2006) RA1.3 RA2 RA3

The requirements overleaf were used to evaluate the five commonly used modelling techniques previously described.

**Table 8 - Evaluation of techniques against the requirements**

		Process Modelling Technique				
		Flowchart	IDEF	UML	BPMN	SysML
Requirement #	RT1.1	N	N	Y	N	Y
	RT1.2	N	Y	Y	N	Y
	RT1.3	Y	Y	Y	Y	Y
	RT1	<b>N</b>	<b>N</b>	<b>Y</b>	<b>N</b>	<b>Y</b>

Only two of the five common process modelling techniques meet the requirements for the modelling exercise in this work: the UML and the SysML, both allowing for the modelling of the process requirements, information, and activities. The flowchart and BPMN techniques focus solely on the behavioural aspects of the process (activities), and the IDEF technique does not have requirements modelling functionality. As these techniques do not fulfil all of the sub-level requirements, they do not meet the overall requirement RT1.

Both the UML and the SysML offer the same level of functionality for process modelling. Since the strategy design approach is not directed at a systems engineering audience, and given that the UML is mandated in some areas by UK Government, the UML technique will be used in this work.

### 3.3 A Framework for Process Modelling

A framework is a structure which provides support or guidance for building something (Rouse, 2015). A process modelling framework, therefore, is a structure which supports or guides the 'building' of a process model. Perry (2006) highlights the importance of process modelling frameworks in ensuring that both the behaviour and structure of a process are sufficiently captured and understood. For example, applying the UML without a supporting framework might only produce an activity diagram, thereby neglecting the structural aspects of the

process. Holt (2005) offers a holistic framework for process modelling which provides for the three views specified in my requirements (information, activities, and process requirements), and considers a further four views (stakeholder, structure, content, and instance).

Holt's *Seven Views* framework is recognised within industry as offering 'formalisation and completeness' to process modelling (Brownsword, 2009). It has been adopted as the best practice approach for process modelling by the British Standards Institution (BSI) and has been used to develop industry processes including the Transport for London *Requirements Management Process* (TfL, 2013) and a *Formalised Approach to the Management of Risk* (Brownsword, 2009). Although the framework is presented using the UML, it can support any process modelling notation that is 'sufficiently rich and expressive' to capture the seven views (Perry, 2006). Presently, however, only the UML meets this requirement.

## 4 The Strategy Design Model

In Chapter 2, two groups of processes associated with strategy were identified: strategy design and strategy delivery. As discussed in the literature review, strategy delivery processes have historically been well researched and documented. In the following section, I present a model for the strategy design process group. The strategy design model has been developed using the Seven Views framework and is illustrated using the Unified Modelling Language. Each of the seven views will be described and justified below in the specific context of the strategy design approach.

### 4.1 UML Diagrams

Four different UML diagrams are used to illustrate the seven views of the strategy design model, as shown in Figure 28. The *use case* diagram is used for modelling stakeholder expectations of the process in the requirements view. The UML *sequence* diagram illustrates particular scenarios associated with the process in the process instance view. The *class* diagram is used to show the information, stakeholder, process structure, and process content views. Finally, the *activity* diagram depicts the behavioural aspect of the process model in the



process behaviour view. Each of these diagrams will be further explained as they are presented in the following section.

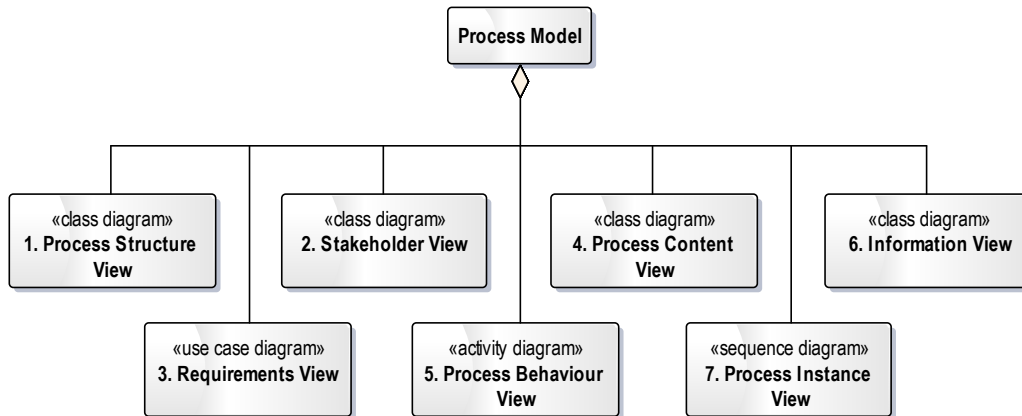


Figure 28 - UML diagrams used to depict the seven views (author, 2015)

## 4.2 Using the Processes

Figure 29 shows an overview of the three strategy design processes: Plan, Capture and Communicate. The processes are intended to be suitable both for designing new strategies and for renewing and updating those which already exist. For the latter, the previously disseminated strategy becomes an input to the Plan process, which should be carried out first for any design exercise. The Capture and Communicate processes may follow an iterative cycle until the communicated strategy is ready for dissemination.

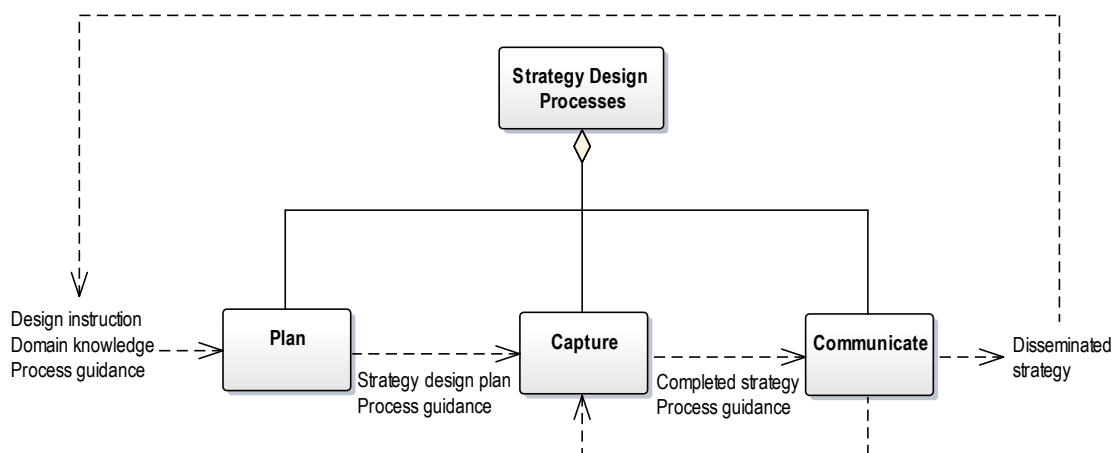


Figure 29 - Iteration of the strategy design processes (author, 2015)

## 4.3 The Seven Views of Strategy Design

### 4.3.1 Process Structure View

The seven views of the process modelling framework can be realised in any order. I begin with the process structure view, which shows the basic structure of the process and establishes the terminology that will be used throughout the process description. This view enables a correlation between terminology used in different process models, thereby benefitting any future audits or assessments (Holt, 2005, p. 64). The process structure view is represented in a UML Class diagram, as used in Chapter 4 to depict the structure and content of strategy documents. Figure 30 shows the process structure view for strategy design. I have extended Holt's simple process structure view (2005, p. 64) to demonstrate the relationship between the terms *process* and *approach* in this work.

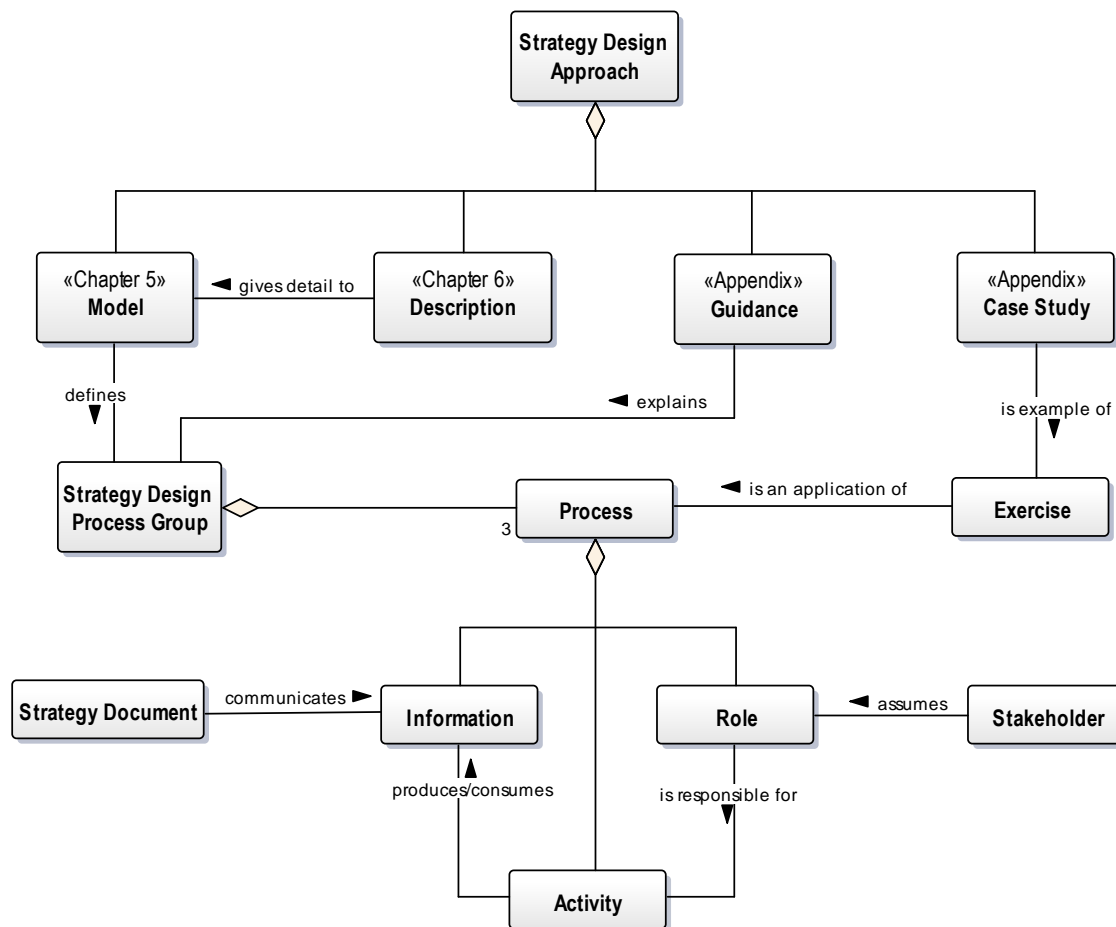


Figure 30 - Strategy design process structure view (author, 2015)

The boxes in the diagram (called *classes*) represent different concepts related to the work. The lines connecting two classes show a *relationship* between the concepts. The diamond-shaped arrowhead signifies that the parent class *is made up of* a number of component classes. For example, the strategy design approach is made up of a model, a description, guidance, and a case study. A number attached to a relationship shows how many instances exist of that particular class. In this case, the strategy design process group is made up of three processes. A direct line between two classes represents a basic relationship between the two concepts, often elaborated with the use of a label. For example, the strategy document communicates the (strategy) information. A behavioural step in the process is called an *activity*, which is the responsibility of a *role*. Anything which is produced or consumed in the process is called *information*.

#### 4.3.2 Stakeholder View

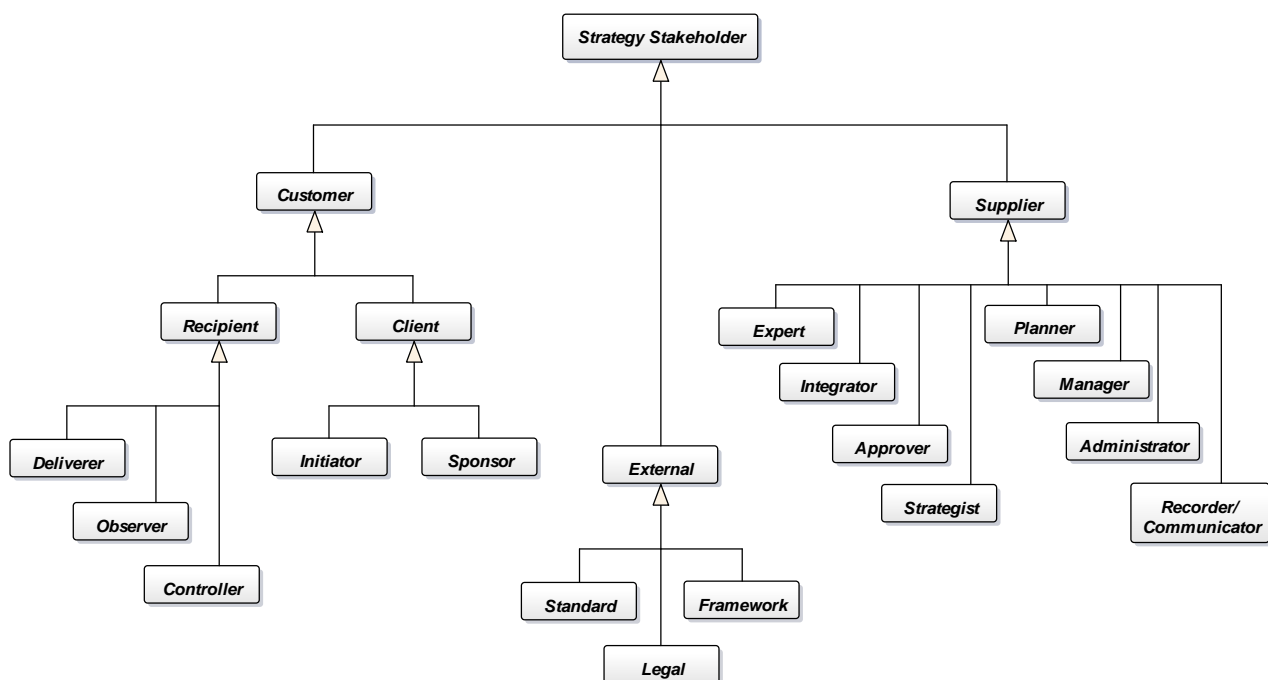


Figure 31 - Strategy design stakeholder view (author, 2015)

The second view presented is the stakeholder view, which identifies the different types of stakeholders interested in the process. This view contributes to understanding the ‘big picture’

of the organisation or system and to ensuring consistency between different processes (Holt, 2005, p. 75). Figure 31 shows the stakeholder view for strategy design. Stakeholders were identified through reviewing relevant literature (Chapters 2 and 3), conducting stakeholder interviews (Gaynor, 2014) (Brennan, 2014) (Randall, 2014), and performing iterations of the process modelling exercise. For example, if an extra stakeholder was identified while developing the process behaviour view (Figure 35), this information was added to the stakeholder view.

The stakeholder view is represented in a UML class diagram, as was used for the process structure view. The arrow-head relationship signifies that the child class *is a type of* the parent class. For example, the Sponsor stakeholder is a type of Customer. The three stakeholder types have been adopted from the generic stakeholder view (Holt, 2005, p. 77). These are:

- Customer – those which have an interest in or will work with the strategy
- Supplier – those which are responsible for designing the strategy
- External – those which impose rules or structures on the strategy design exercise

It should be noted that the stakeholder name does not relate to a particular job title, but rather describes the role of that stakeholder. For example, the Strategist role might not hold the title of Strategist in the organisation, but is responsible for making strategic decisions. It should also be remembered that the view has been developed in the context of strategy design. Therefore, in the railway strategy example, the Sponsor stakeholder does not represent sponsors of the railway system, but sponsors of a railway strategy. Each stakeholder role is further described below.

### **Customer**

- Initiator (client) – requests the design of the strategy. For example, the Department for Transport or the CEO of a train operating company.

- Sponsor (client) – finances the design of the strategy. For example, a TfL sponsor or the Secretary of State. The Initiator and Sponsor are often the same person or body.
- Observer (recipient) – has a passive interest in the output strategy. For example, the UK rail industry or the general public.
- Deliverer (recipient) – is responsible for putting the strategy into practice. For example, academic institutions or engineering project delivery teams.
- Controller (recipient) – updates, develops or maintains the strategy. For example, RSSB or the Department for Transport.

### **Supplier**

- Expert – has domain expertise and provides professional knowledge to design the strategy. For example, rolling stock specialists or economists.
- Integrator – brings together the individual areas of the strategy into a whole and ensures that traceability is maintained. For example, the project leader or a consultancy organisation.
- Approver – approves the strategy at different stages of its design, including the final approval. For example, the budget holder or CEO.
- Strategist – makes strategic decisions based on the expert input. For example, the director of infrastructure strategy or the executive board.
- Planner – decides and organises how the strategy design will be carried out. For example, a project manager or consultancy organisation.
- Manager – assigns tasks and manages the time and budget of the strategy design. For example, the project manager or head of strategy.
- Administrator – collects the required source information to inform the strategy. For example, an administrative assistant or database operator.

- Recorder/Communicator – captures and communicates the information produced throughout the exercise. For example, a technical writer or an area lead.

## **External**

- Standard – any standard procedures or tools which must be adhered to when designing the process. These may be internal or external to the organisation. For example, Information Management policies or interview templates.
- Legal – any legal requirements which must be adhered to when designing the strategy. For example, the Railways Act 2005 or confidentiality laws.
- Framework – any rules or structures that will guide the strategy design. For example, the INCOSE Competency Framework or this strategy design approach.

### 4.3.3 Requirements View

The third view presented here is the requirements view, which describes the overall aims of the process. This view is important for validating the process once it has been defined (Holt, 2005, p. 61). In Chapter 4, a set of requirements for the strategy design approach was defined based on the literature review, the railway system case study, and the evaluations of existing strategy documents. In this section, the requirements of the identified stakeholders are taken into account and added to the requirements set. Figure 32 shows the stakeholder requirements view in a UML use case diagram. The ‘stick-men’ on the diagram represent stakeholder roles (called *actors*), which can include people, organisations, and places. The ellipses are *use cases*, which show the required functions or capability of the process. They can be expanded by using more detailed use cases with *include* or *constrain* relationships. A line connecting an actor to a use case shows a relationship between the two. A box surrounding the use cases shows the boundary of the system.

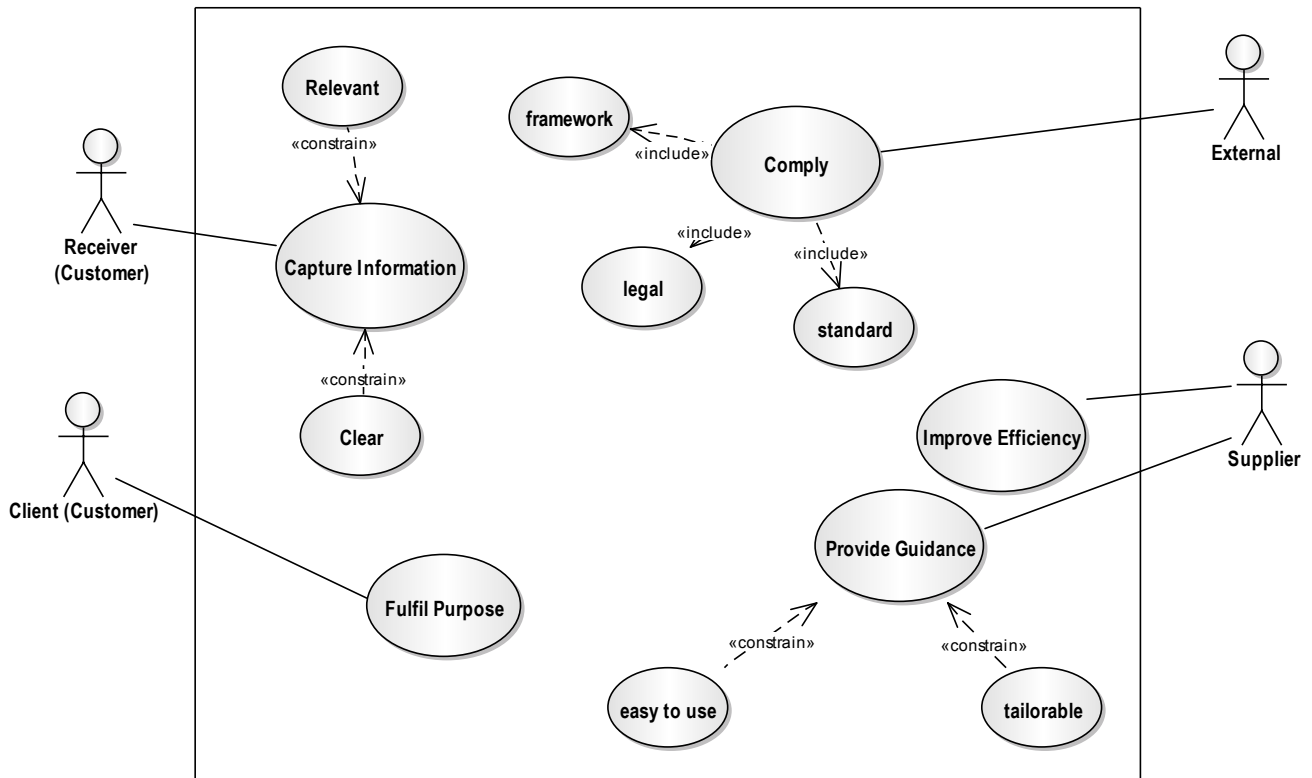


Figure 32 - Strategy design stakeholder requirements view (author, 2015)

The *Customer* group of stakeholders is generally interested in the final output of the strategy design exercise. The receivers of the strategy require relevant strategy information to be clearly communicated. The clients for the strategy are concerned with whether the completion of the strategy design exercise has achieved its original intended purpose. For example, if an infrastructure strategy was delivered where a rolling stock strategy was required, the Client role would not be satisfied.

The *Supplier* group, which designs the strategy is generally concerned with the usability of the process model and the associated guidance. The model should allow for the user to tailor it according to the organisation's need and the guidance should be easy to use. A common approach to strategy design should also improve the efficiency of strategy design exercises within the organisation.

The *External* group of stakeholders has an interest in both the processes and the output of the strategy design approach. The approach should include the consideration of any relevant standards, legal requirements or frameworks.

Table 9 shows the amalgamation of the requirements set established in Chapter 4 and the stakeholder perspectives. Additions to the table are shown in red. The list represents the complete set of requirements for the strategy design approach.

**Table 9 - Strategy design complete requirements set**

Requirement #	Text
RA1	The approach shall include a process model.
RA1.1	The process model shall be generic.
RA1.2	The process model shall be holistic.
RA1.3	The process model shall be aligned with systems engineering principles.
RA1.4	The process model shall apply the defined terminology.
RA2	The approach shall include strategy communication.
RA2.1	The approach shall support effective communication.
RA2.2	The approach shall support the use of any communication tool.
RA3	The approach shall include guidance.
RA3.1	The guidance shall use the defined terminology.
RA3.2	The guidance shall reference model-based communication.
RA3.3	The guidance shall reference natural language communication.
RA3.4	The guidance shall cover how to produce a strategy document.
RA3.5	The guidance shall be easy to use.
RA4	The approach shall improve the efficiency of strategy design exercises.



#### 4.3.4 Process Content View

The fourth view presented is the process content view, which shows the activities and information that make up each of the strategy design process. This view offers a simple and concise way of representing the structure and complexity of an entire process group (Holt, 2005, p. 70). The process content view is represented by a UML class diagram (Figure 33), as used in the process structure and stakeholder views. The view shows the behavioural and structural aspects of the three strategy design processes; Plan, Capture and Communicate. Process activities (behaviour) are preceded by a + symbol (e.g. consider context) and information (structure) is preceded by a - symbol (e.g. list of experts) in the attributes of each process class.

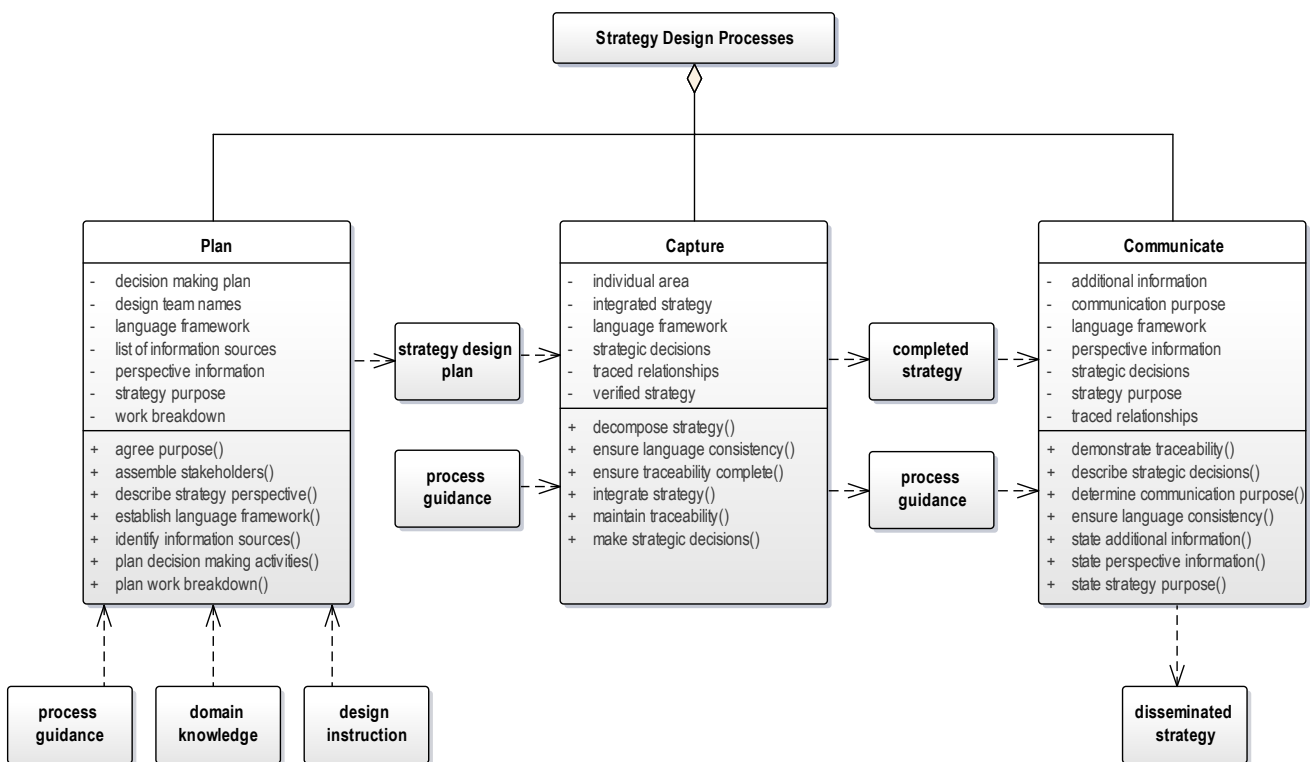


Figure 33 - Strategy design process content view (author, 2015)

The behaviour and structure of each process were established through the iterative development of the process behaviour and process information views. This is demonstrated in Figure 34. The first version of the views was informed by the process requirements set. The views were further developed until they were consistent and no further amendments were necessary. Miller's 'magical number' proposition (1956) was taken into account when determining the level of detail that should be included in the process content view. Each process therefore comprises approximately  $7 \pm 2$  activities and information elements. For example, the *perspective description* information actually encompasses *context description*, *scope description* and *lifecycle description*, which are not shown on this view but feature in the information view.

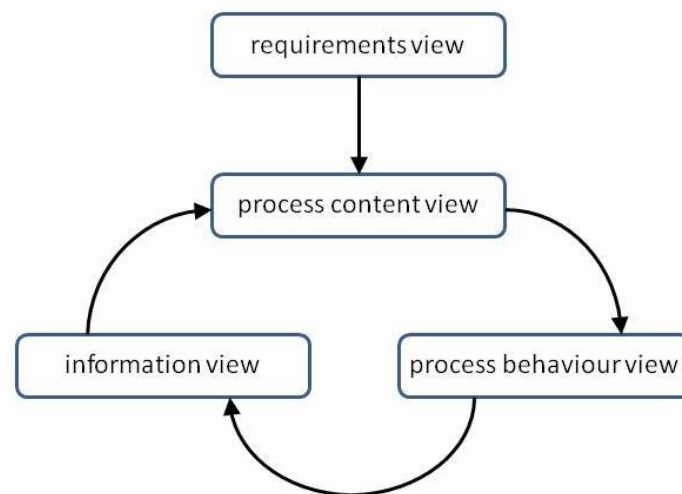


Figure 34 - Strategy Design process development cycle (author, 2015)

To demonstrate how the activities and information of the processes were identified, Table 10 shows the link between each attribute and the related requirement or other justification. In Chapter 7, I will also illustrate how the approach requirements have been fulfilled through the behaviour and structure of the processes.

**Table 10 - Traceability between process activities and requirements**

	Activity	Related Requirement	Details
Plan	Agree purpose	RA1.3	Aligns with <i>understanding the problem</i> SE principle.
	Assemble design team	derived	Stakeholders will need to be identified in order to execute the activities.
	Describe strategy perspective	RA1.3	Aligns with <i>context</i> SE principle.
	Establish language framework	RA2, RA2.1	Specified by communication requirements.
	Identify information sources	RA1.3	Aligns with <i>planning</i> SE principle
	Plan decision making activities	RA1.3	Aligns with <i>planning</i> SE principle
	Plan work breakdown	RA1.3	Aligns with <i>planning</i> SE principle
Capture	Decompose strategy	RA1.3	Aligns with <i>decomposition &amp; integration</i> SE principle
	Ensure language consistency	RA2, RA2.1	Specified by communication requirements
	Ensure traceability complete	RA1.3	Aligns with <i>traceability</i> SE principle
	Integrate strategy	RA1.3	Aligns with <i>decomposition &amp; integration</i> SE principle
	Maintain traceability	RA1.3	Aligns with <i>traceability</i> SE principle
	Make strategic decisions	RA1.2	The systems approach should include decision making activities
Communicate	Demonstrate traceability	RA1.3, RA3.4	Aligns with <i>traceability</i> SE principle
	Describe strategic decisions	RA3.4	Specified by communication requirements
	Determine communication purpose	RA2, RA3.4	Specified by communication requirements
	Ensure language consistency	RA2	Specified by communication requirements
	State additional information	derived	Some communicated strategies will be supported by additional information than that specified here.
	State perspective information	RA1.3, RA3.4	Aligns with <i>context</i> SE principle
	State strategy purpose	RA1.3, RA3.4	Aligns with <i>understanding the problem</i> SE principle

#### 4.3.5 Process Behaviour View

The fifth view presented is the process behaviour view, which describes the behaviour of each process through the ordering of activities and identification of responsible stakeholders. This view is stipulated by the rules of UML, which state that any class which exhibits behaviour must have an associated activity diagram to show this behaviour (Holt, 2005, p. 73). Therefore, the three processes identified in the process content view must each have a corresponding process behaviour view, as they each exhibit behaviour (activities). The process behaviour view is represented in a UML activity diagram. Figure 35 shows the behaviour view for the strategy Plan process.

The rounded boxes in the activity diagram represent the activities identified in the process content view. The black circle represents the starting point of the process, with the 'polo' shaped circle showing the end of the process. The arrows show the order that activities should be completed; those which are contained within two black horizontal lines are carried out in parallel. The activity diagram also shows which stakeholder from the stakeholder view is responsible for each activity. The order of activities was determined during the iterations shown in Figure 34, based on logic and feedback during the case study. Several variations of the behaviour view were developed before arriving at the final version presented here. Each of the activities is explained in detail in the accompanying textual description presented in Chapter 6.

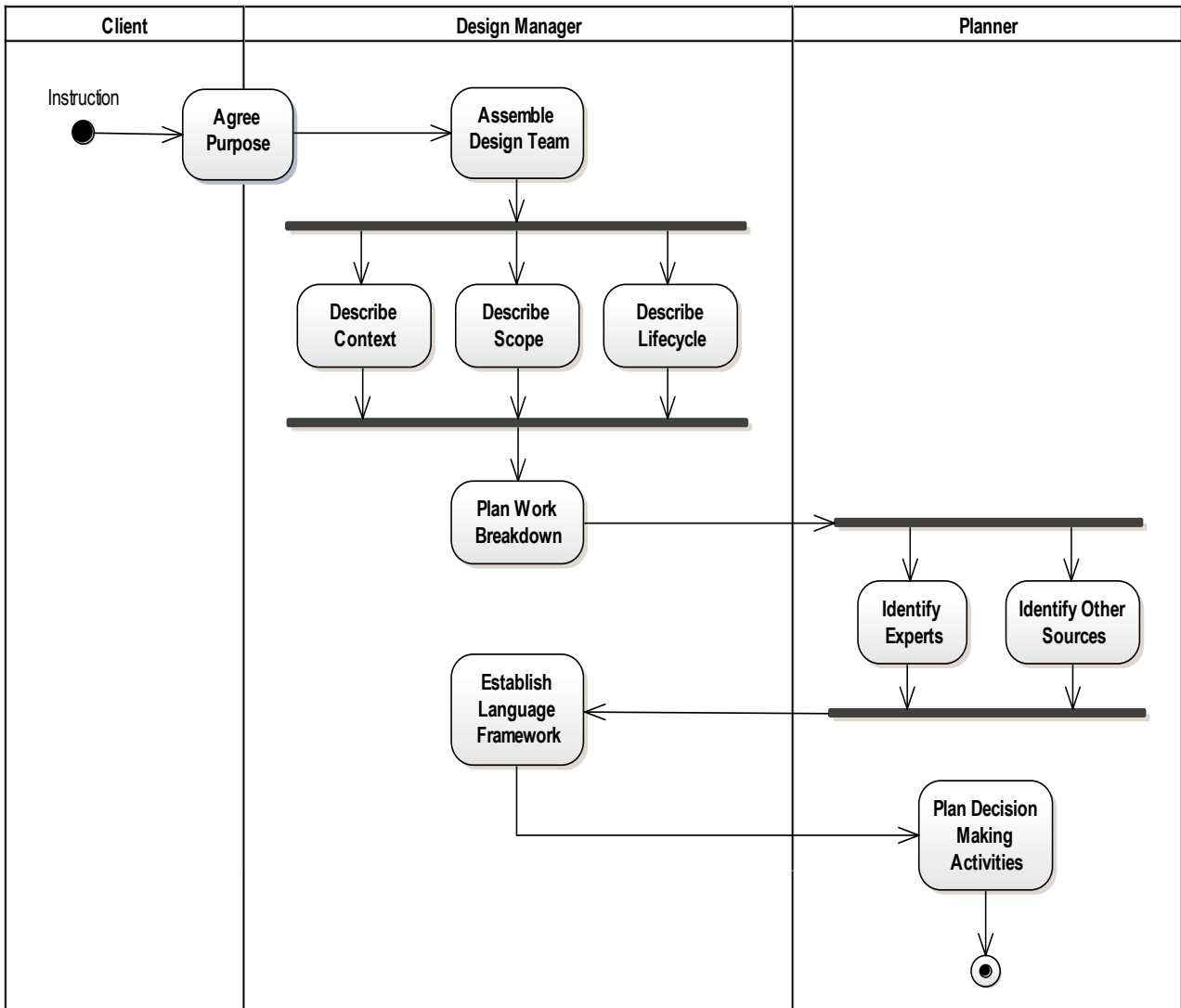


Figure 35 - Strategy design Plan process behaviour view (author, 2015)

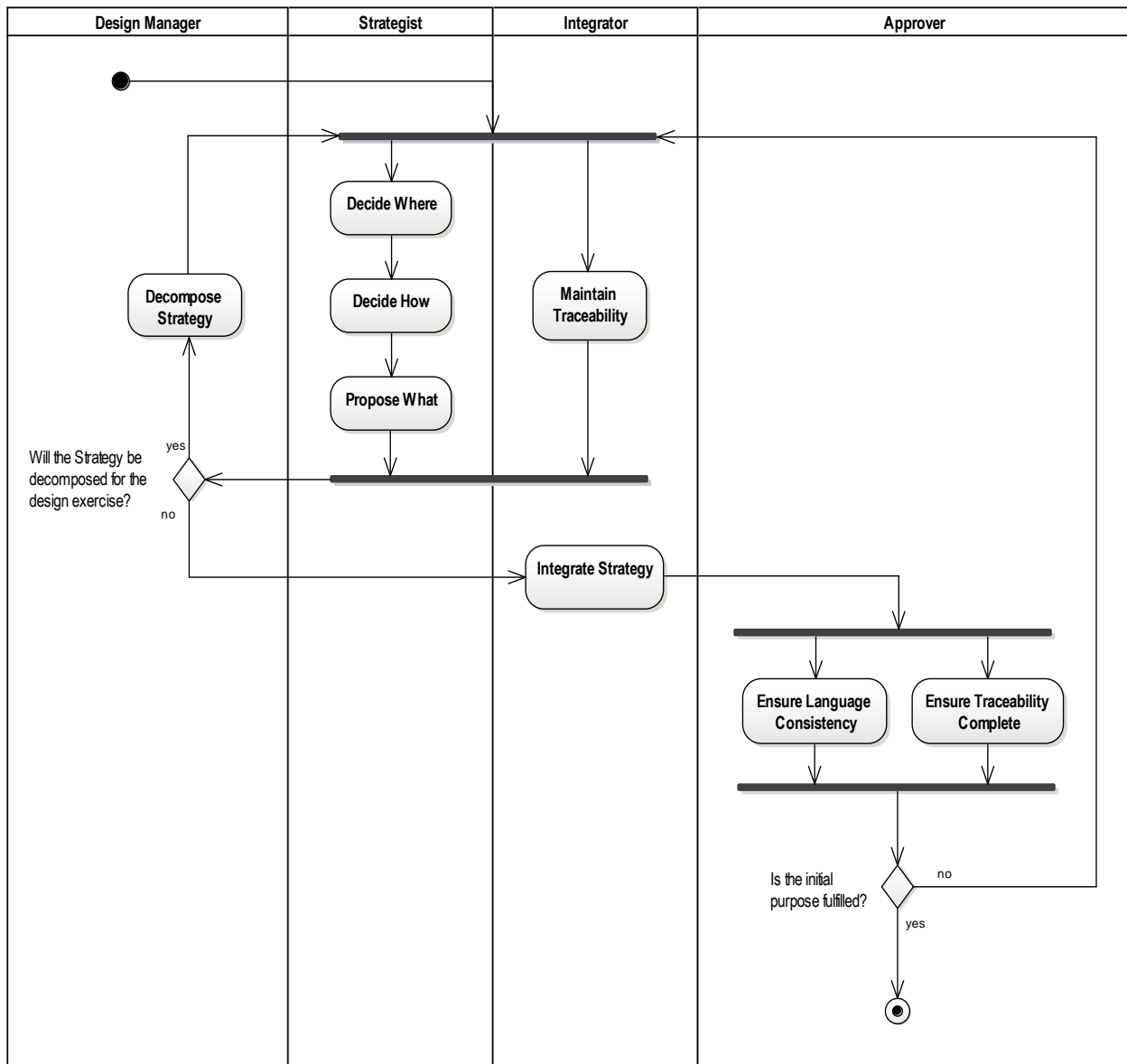


Figure 36 - Strategy design Capture process behaviour view (author, 2015)

Figure 36 shows the behaviour view for the strategy Capture process. This activity diagram is slightly more complex as it also includes decision points, represented by a diamond shape. The Capture process is influenced by the Planning process, as the information produced in the former is consumed by the latter. The process is described in further detail in Chapter 6.

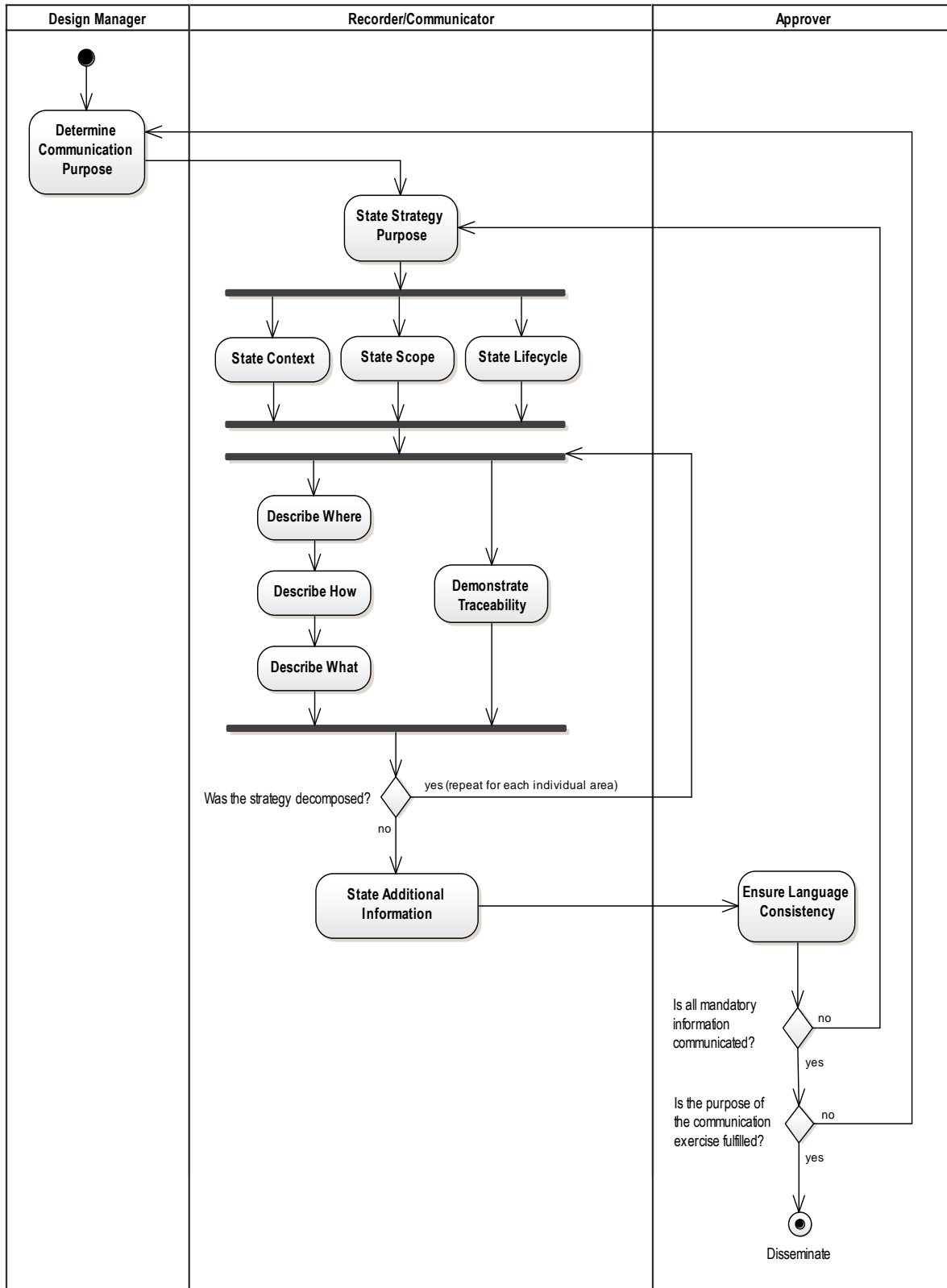


Figure 37 - Strategy design Communicate process behaviour view (author, 2015)

Figure 37 shows the behaviour view for the strategy Communicate process. This process is heavily influenced by the Plan and Capture processes, which produce the information that will be communicated during the Communicate activities. A detailed textual description of the process is provided in Chapter 6.

#### 4.3.6 Information View

The penultimate process view presented is the information view, which identifies the information produced and consumed by a process and the connecting relationships. This view is crucial for maintaining consistency between different processes and for understanding how different pieces of information relate to one another (Holt, 2005, p. 75). This view is shown in a UML class diagram, as used for the process structure, stakeholder, and process content views. Figure 38 shows the information view for the Plan process.

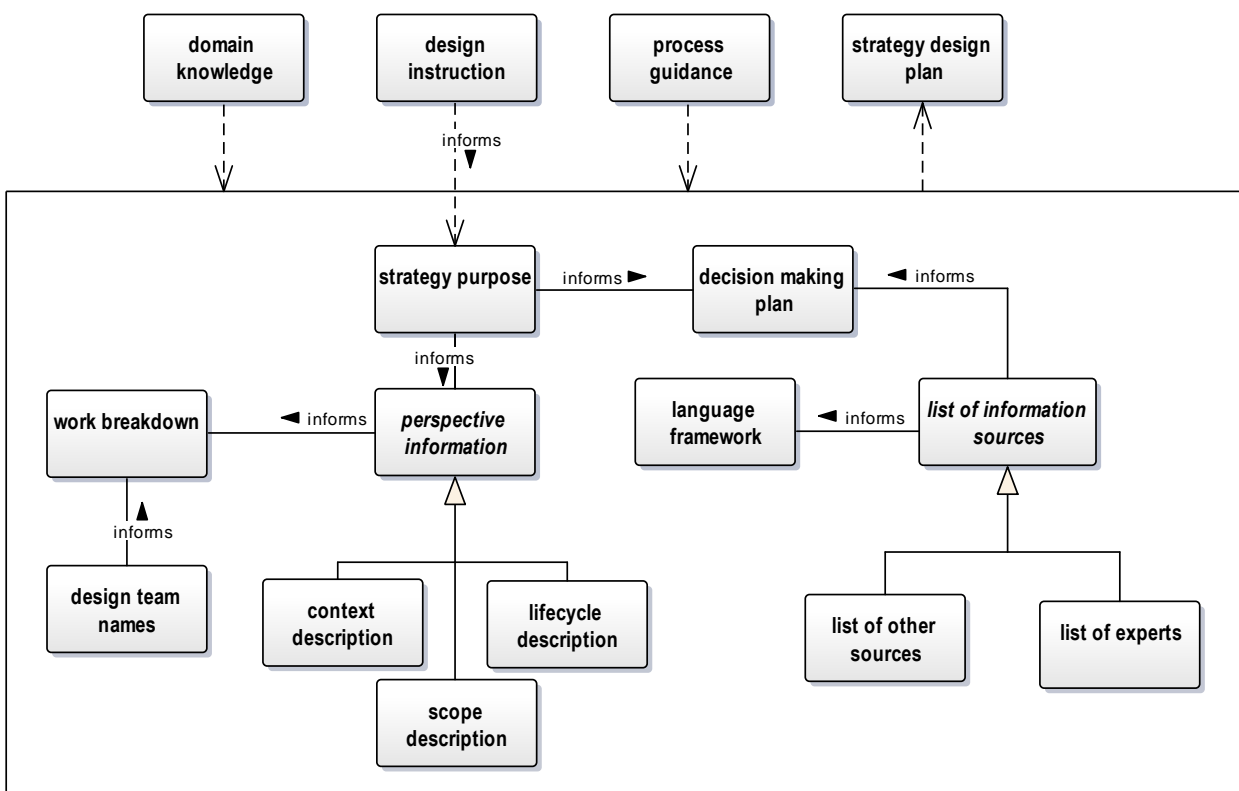


Figure 38 - Strategy design Plan process information view (author, 2015)



Each class in the diagram represents information produced or consumed by the process. Activities in the process will produce and/or consume at least one piece of information. The information elements shown in this view correspond to those identified in the process content view. The initial design instruction, process guidance and domain knowledge are inputs to the Plan process. The output of the process is a strategy design plan, which could be documented or simply discussed. The *perspective information* and *decision making sources* classes are higher level categories comprising detailed information classes.

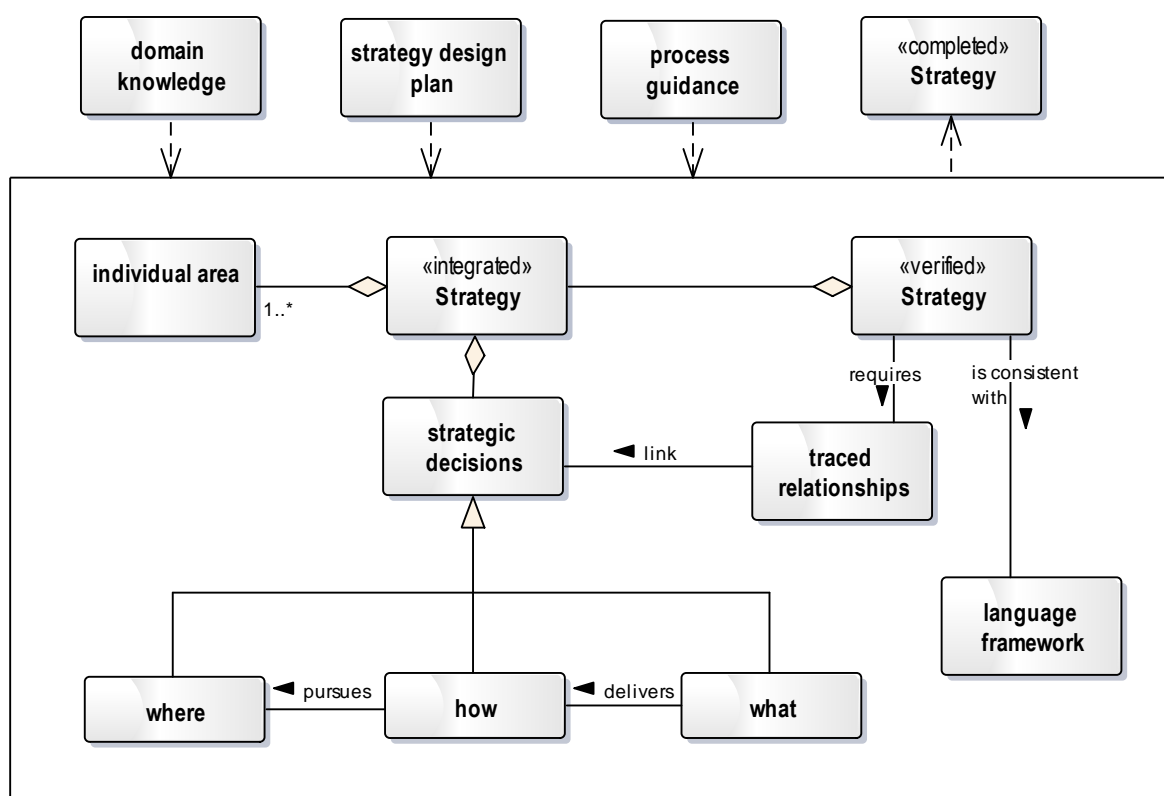


Figure 39 - Strategy design Capture process information view (author, 2015)

Figure 39 shows the information view for the Capture process. The strategy design plan and the process guidance are inputs to the Capture process. The output is a completed strategy (information), stating *where* the organisation or system is envisioned to be, *how* it plans to get there, and *what* activities will be carried out to achieve this.

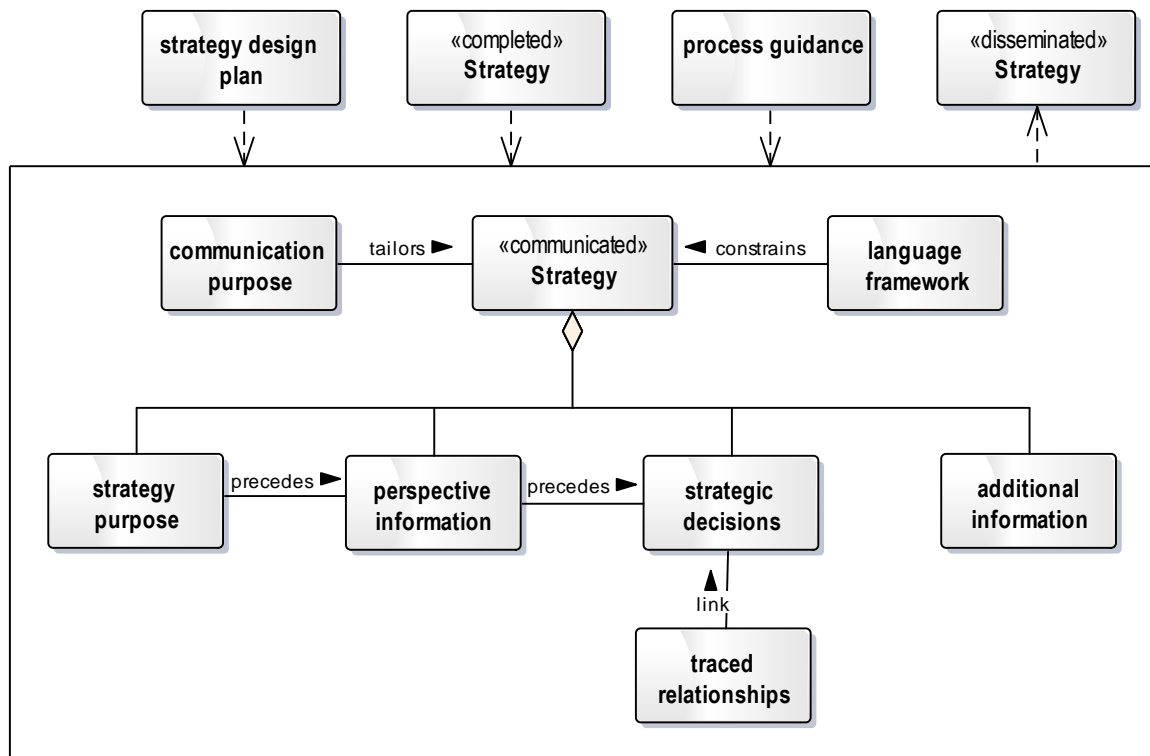


Figure 40 - Strategy design Communicate process information view (author, 2015)

The information view for the Communicate process is shown in Figure 40. The strategy design plan, the process guidance, and the completed strategy are inputs to the Communicate process. The output is the disseminated strategy, either as a strategy document or other method of dissemination, as established in the strategy design plan. The Communicate process is tailored according to the purpose of the communication exercise and constrained by the language framework established in the Plan process.

#### 4.3.7 Process Instance View

The final view of the strategy design model is the process instance view, showing one possible order in which the processes can be executed in a strategy design exercise. This view can be useful for relating the defined processes to the original process requirements (Holt, 2005, p. 77). The process instance view is presented as a UML sequence diagram. The box and dotted line on the diagram is a *life line*, representing individual instances of a process. The arrow symbol, a *flow line*, illustrates the flow of control or information between processes.

Figure 41 shows the theoretical ideal sequence of the processes.

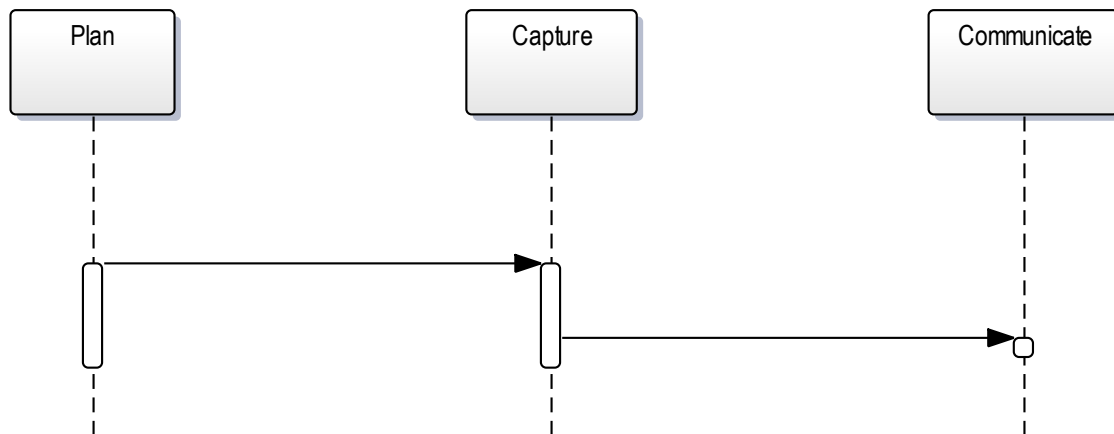


Figure 41 - Strategy design process instance view (ideal) (author, 2015)

In a perfect scenario, the strategy would be fully planned before being captured and then communicated. However, in actuality, it is likely that some information already exists in order to initiate the strategy design exercise. For example, a decision may have been made regarding where the organisation aims to be in ten years, thus identifying the need for a strategy. Figure 42 shows a more pragmatic sequence for a particular strategy design exercise. In this scenario, strategic decisions are captured and communicated before a strategy is requested. The strategy design is then planned, and some aspects are communicated before the whole strategy is complete. Finally, the whole strategy is captured and subsequently communicated.

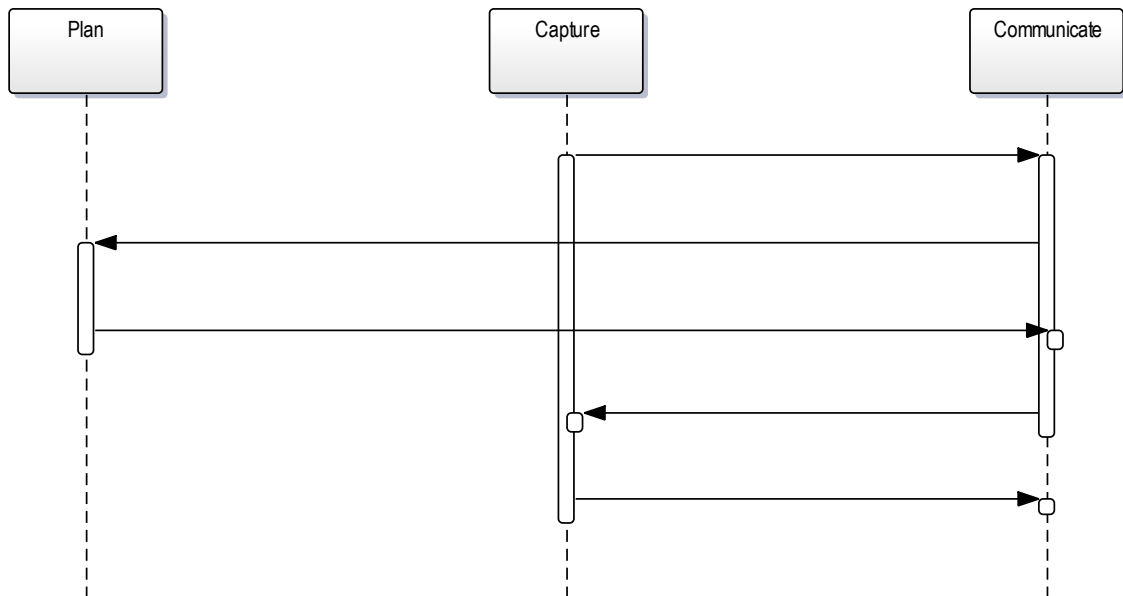


Figure 42 - Strategy design process instance view (pragmatic) (author, 2015)

Although the Strategy Design processes can be executed in any order, the activities are designed to ensure the completion of the Plan and Capture processes before the final strategy is communicated. For example, as the *statement of purpose* is determined during the Plan process, the communicated strategy will be incomplete if the Plan activities have not been fully executed.

#### 4.3.8 Overview

Figure 43 shows how the seven views of the model are related to one another. The process realisation view is useful for visualising where consistency must be maintained across the model.

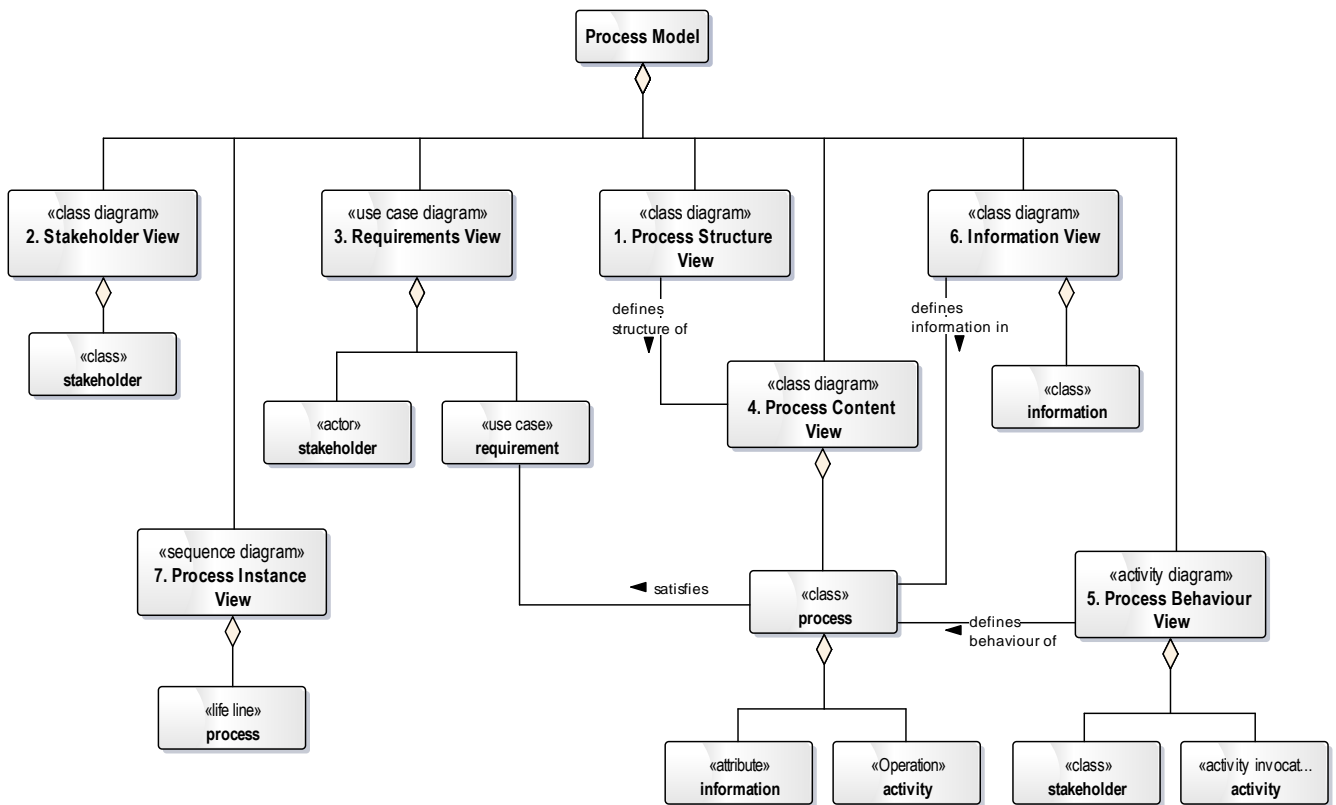


Figure 43 - Strategy design process realisation view (author, 2015)

#### 4.3.9 Traceability

As shown in Figure 43, each element in the strategy design model is related in some way to another element. It is therefore critical that consistency be maintained across the elements in different diagrams (Holt, 2005, p. 42). Table 11 provides a view of the consistency relationships that are relevant to the seven views framework. The views in the strategy design model have been checked for consistency against this table. For example, the *consider scope* activity is presented by the appropriate symbol in the process structure, process content and process behaviour views. Furthermore, the name and relationships with other elements are consistent across the views.

**Table 11 – Consistency between the seven views (Holt, 2005)**

Concept	View	Realised in UML by
Stakeholder	Requirements view	<<actor>>
	Process behaviour view	<<swim lane>>
	Stakeholder view	<<class>>
Activity	Process structure view	<<class>>
	Process content view	<<operation>>
	Process behaviour view	<<activity invocation>>
Artefact	Process structure views	<<class>>
	Process behaviour view	<<object>>
	Process content view	<<attribute>>
	Information view	<<class>>
Process	Process structure view	<<class>>
	Process content view	<<class>>
	Process instance view	<<life line>>

## 5 Summary

In this chapter, I have presented the model for strategy design developed during this research. It includes a justification for selecting the UML modelling technique, based on the requirements defined in Chapter 4. I have introduced the Seven Views process modelling framework and explained each view of the strategy design model. The process structure view shows the basic structure of the Strategy Design approach and establishes the terminology that will be used throughout the process description. The stakeholder view identifies those which are interested in strategy design and informs the requirements view. Three processes have been defined in the model: Plan, Capture and Communicate, which are described in the process content, process behaviour and information views. The process instance view shows two possible sequences for executing the processes in different scenarios. In Chapter 6, I describe the three processes in greater detail, based on the process behaviour views. Standalone guidance for the approach and an example case study, which are designed to support strategy design exercises, are included in the Appendix.

# CHAPTER 6

## APPLYING THE STRATEGY DESIGN APPROACH

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### 1 Introduction

In Chapter 5, a model for Strategy Design was presented through seven different views. Together, the views constitute the skeleton of the Strategy Design processes, describing their stakeholders, requirements, structure and behaviour. In the present chapter, I add detail to the model in the form of a textual description. Each activity from the process behaviour views will be explained in further detail and demonstrated through a case study. Although the case study has a railway industry context, the processes are generic and can be tailored according to the particular needs of each user. Standalone guidance for the processes and the full case study are included in the Appendix. At the end of this chapter, I provide a preliminary evaluation of the approach and propose further evaluation options for future work.

### 2 Case Study

The case study is based on a hypothetical strategy design exercise for the Birmingham Centre for Railway Research and Education (BCRRE, 2015). The Centre is a prominent part of the University of Birmingham and is one of the largest railway research groups in Europe. In recent years, BCRRE has expanded at a rapid rate, both in terms of research and education activities, and in the number of personnel. The Centre has grown in an organic fashion, largely without limiting its research activities or future direction. However, as BCRRE continues to grow, its leaders recognise the increasing need to ensure the sustainability and future success of the group. In order to plan for the longer term, the Centre must develop a strategy. To test the consistency and logic of the approach developed in this work, a hypothetical strategy design exercise was carried out for the BCRRE example. In the work which follows, alongside each activity description, I describe how the activity was executed for the case study. The fully

worked examples of each activity, including diagrams, are provided in the Case Study document.

### 3 Strategy Design Overview

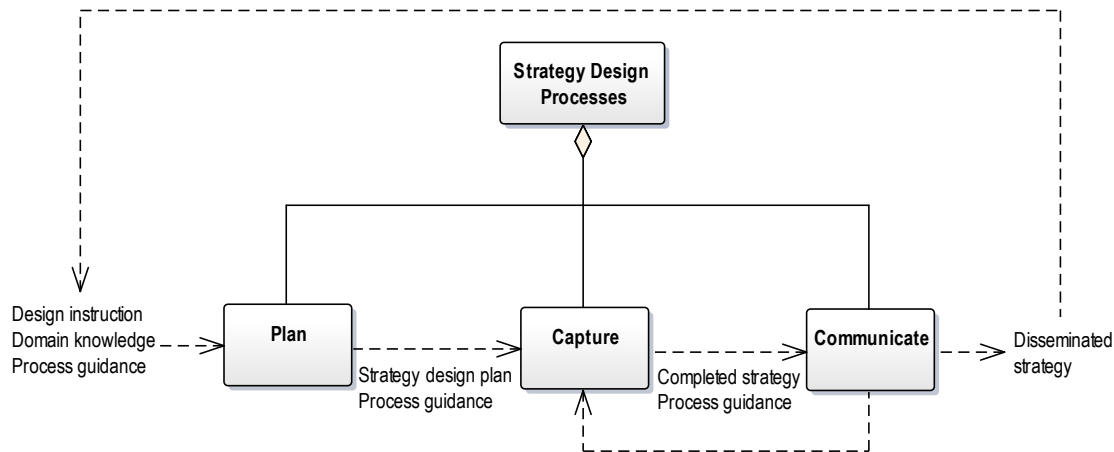


Figure 29 – Iteration of the strategy design processes (author, 2015)

The strategy design model identifies three associated processes: Plan, Capture, and Communicate. Figure 29 shows an overview of the processes, including information which is transferred from one process to the next. A strategy design exercise begins with an initial instruction to design a strategy, which might be a new creation or an update to one that already exists. Combined with domain knowledge and the process guidance, this is the information required to carry out the Plan process. Following this first process, a strategy design plan will have been developed, which might be a formal document or simply a mental record. This plan is required to perform the Capture process, alongside the process guidance and input from a decision making process. The outcome of the Capture process is a completed strategy. Finally, information produced by activities in the Plan and Capture processes will be used in the Communicate process. The communicated strategy might only contain a selection of the information produced during the plan and capture of the strategy. The three processes will be explained further below, including an example application for the case study.



## 4 Plan Process

### 4.1 Overview

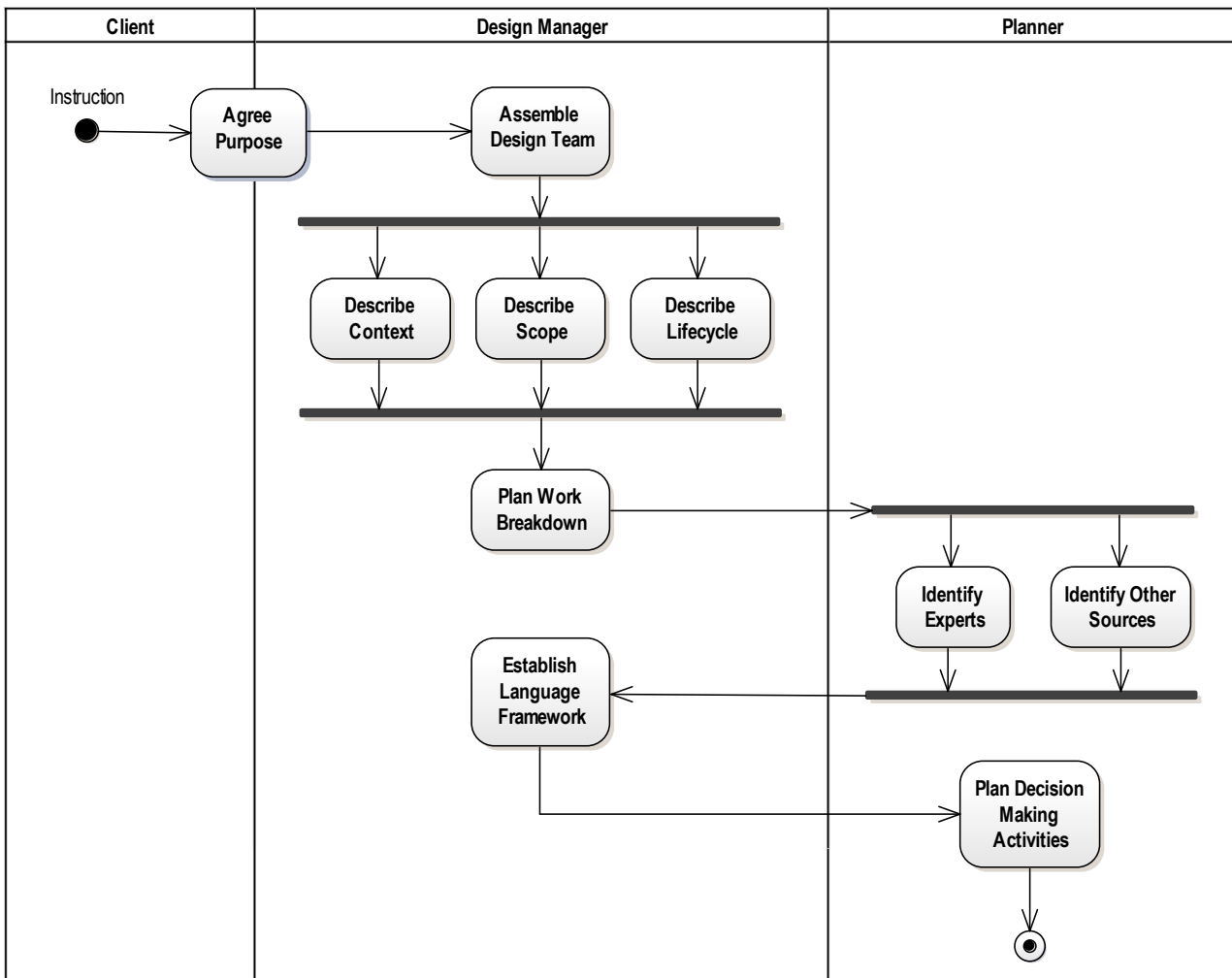


Figure 35 – Overview of the strategy design Plan process (author, 2015)

The first of the Strategy Design processes is Plan. The purpose of this process is to plan the activities that will be executed during the Capture and Communicate processes. At the end of the process, the user will have established a plan for capturing and communicating the strategy, whether as a formal document or other medium. In a small organisation, there may only be one person responsible for developing the strategy. In this case, the Plan process could prompt the individual to plan adequately rather than hastily designing the strategy. The Plan process includes assembling the design team, identifying information sources, and planning

the specific activities to capture and communicate the strategy. Figure 35 shows the order of the activities which make up the process and the role responsible for each. The process begins at the black circle and is completed when the user reaches the ‘polo’ shaped circle at the end of the sequence. The activities and team roles will be explained in further detail below. Examples and references to additional resources are provided in the Guidance document in the Appendix.

## 4.2 Stakeholders and Roles

There are three main roles responsible for planning the strategy. These are:

- The **Client** – requests or initiates the design of the strategy. This role may also finance the work.
- The **Design Manager** – agrees the work with the Client, assembles the design team, and organises the workload.
- The **Planner** – decides and organises how the strategy design will be carried out.

Although three different *roles* are responsible for planning the strategy production, this does not necessarily equate to three individual *people*. For example, the Design Manager and the Planner roles may be performed by the same person. Likewise, in a very small organisation, it is possible for the Client to be the same person that develops the strategy (for example, the CEO). It should also be noted that the name of the role does not relate to a particular job title, but rather describes the role played during this process. For example, the Design Manager role does not need to hold the title of *Design Manager* in the organisation.

## 4.3 Plan Activities

### 1. Instruction

The Plan process begins when an instruction to design a strategy has been received. This could take the form of a spoken instruction during a meeting, a government policy document, a letter, or even an email.

**Case Study Application:** The Plan process is initiated when the BCRRE Director asks the Head of Development to lead the design of a five year strategy focused on ensuring the future sustainability of the Centre.

## 2. Agree Purpose

Before designing the strategy, it is important to understand the reason for undertaking the exercise and the required outcome(s). Without this step, it would be very difficult to determine whether the work has achieved what was initially required. The responsibility for this activity lies between the Client and the Design Manager roles, to ensure that there is a common understanding. At the end of the design exercise, the Client will measure the success of the work by whether it meets the initial purpose. To reduce the risk of misunderstanding, it is recommended that the purpose be captured and agreed by both parties. It is also useful to agree specific measures that can be checked to confirm whether the purpose has been met. Once agreed, the Design Manager will be responsible for ensuring that the strategy design team understands the purpose throughout the exercise.

**Case Study Application:** The purpose of the BCRRE strategy is to establish the five year vision for the Centre and to determine how its research and education activities can best be aligned to achieve this. The outcome of the design exercise will be a published document and a live online model. The purpose of the strategy was decided during a workshop and agreed by the Director and the Head of Development for BCRRE.

## 3. Assemble Design Team

Once the purpose of the design exercise has been established, and before further activities can be completed, the Design Manager must identify and assemble the team that will design the strategy. For a small scope of work, the team may consist of only one person, whereas a bigger exercise might require a committee. In addition to the Client and Design Manager roles, the following roles should be identified:

- The **Planner** – decides and organises how the strategy design will be carried out.
- The **Strategist** – makes strategic decisions based on input from experts and information sources, using appropriate tools and techniques.
- The **Integrator** – brings together the individual areas of the strategy and ensures that traceability is maintained.
- The **Approver** – approves the strategy at different stages of its capture, including the final approval.
- The **Recorder/Communicator** – captures the information produced throughout the process and communicates it to a specific audience.

In a small organisation, the roles could be performed by the same individual, whereas larger design exercises might require several people in each role. It is likely that the Approver role will be determined by existing governance structures in the organisation.

**Case Study Application:** The roles required to design the strategy will be fulfilled by the following BCRRE personnel:

**Client** – Director of BCRRE

**Design Manager** – Head of Development

**Planner** – Initiative Lead

**Strategist** – Initiative Lead

**Integrator** – Support Staff

**Approver** – Head of Development

**Recorder/Communicator** – Support Staff

The BCRRE organisational chart was referenced to identify suitable team members. The responsible roles will be supported throughout the design exercise by a number of BCRRE domain experts, including teaching, research and support staff.

#### 4. *Describe Strategy Perspective*

The following three activities are related to describing the wider perspective of the strategy. They provide an important overview of how changes to one strategy might impact other strategies, or even the whole system. The three activities can be completed in any order. Although the Design Manager is ultimately responsible for these activities, they should be carried out in collaboration with the other stakeholders in the process.

##### a. Describe Context

Context is related to viewing the strategy as part of a bigger picture and considering its interfaces within the wider environment or system of systems. The activity includes, but is not limited to:

- Identifying stakeholders (those who have an interest in the strategy)
- Illustrating the strategy within its wider environment
- Considering the broader political, strategic and legal landscape
- Naming strategies which must be taken into account
- Naming strategies which might be affected by this strategy
- Naming standards which must be taken into account
- Describing the purpose or goals of the wider environment

**Case Study Application:** A context diagram was developed to understand relationships between the BCRRE strategy and others. The Centre's strategy will be aligned with existing strategies for the Engineering and Physical Sciences College and the University, of which it is part. It will also take into account international strategies such as the EU's transport strategy and government strategies including the Department for Transport's strategy for reforming the railways.

## b. Describe Scope

Scope is very closely linked to Context, and might even be considered as its inward-facing equivalent. It relates to understanding where the boundaries of the strategy lie, and agreeing what is and is not included in the work. This is an essential step for ensuring that the final strategy covers the required areas, and that only necessary work is carried out. Information which might be considered at this stage includes, but is not limited to:

- Timescale of the vision (e.g. ‘a vision for 2050’)
- Intended audience
- Geographic area
- A particular system of interest (e.g. rolling stock)

**Case Study Application:** The scope of the BCRRE strategy includes all research, education and development activities at the Centre to the year 2020. It also includes a high level strategy for the Birmingham International Railway Academy (BIRA), which is the international arm of BCRRE. The intended audience of the strategy is the BCRRE leadership team, who will be responsible for its delivery. The published document will be suitable for dissemination to external contacts.

## c. Describe Lifecycle

The third activity related to perspective is the consideration of the lifecycle of a strategy. This means examining the whole life of the strategy, from the initial instruction to its eventual withdrawal or replacement. This activity is important for planning the delivery of the strategy and understanding how it might evolve with time. It includes, but is not limited to:

- Providing historical context for the strategy
- Referencing previous versions
- Suggesting its expected validity
- Specifying details about future versions

- Proposing a time plan for delivery
- Referencing the lifecycle of other strategies

**Case Study Application:** A Gantt chart was produced to illustrate the timescale of the BCRRE strategy compared to related strategies. The EU White Paper for Transport considers its vision up to 2050, whereas the Rail Technical Strategy looks ahead to the next thirty years. As this is the first strategy for BCRRE, the initial timescale is relatively short, with a focus on putting in place over the next five years the foundations for sustainability. The live version of the strategy will be continuously updated throughout its five year validity. In 2020, it is expected that a new strategy will be developed to take the Centre up to 2030.

## 5. Plan Work Breakdown

Once the purpose and perspective of the strategy have been determined and the stakeholders assembled, the Design Manager must plan how the work will be apportioned. For a small scope of work, the whole strategy might be designed by one person, whereas a more complex strategy might require several sub-teams. This activity includes, but is not limited to:

- Determining whether/how the strategy will be *decomposed* (for example, it may be divided by discipline, such as Rolling Stock and Infrastructure)
- Deciding when strategic decisions will be made and by whom
- Planning how the work will be apportioned
- Stating which stakeholder role will be responsible for each activity (for example, there may be five Strategist roles, each working on one section)
- Creating a work plan with deadlines for each activity
- Deciding how the strategy will be communicated

**Case Study Application:** The BCRRE strategy will be divided into five themes: Education, Research, Customers & Markets, Operations & Processes, and People & Organisation. The themes were established during workshops with the leadership team and reflect the high level

nature of this first BCRRE strategy. Future strategies are likely to provide further detail on specific research areas, such as Data & Energy. The strategy will be captured as a published document, with a live version made available online and regularly updated. An outline timeframe for completing the strategy is provided as a Gantt chart. Once the overall vision, objectives and initiatives for the Centre are determined, the work will be divided into the five core themes. Each theme lead will be responsible for developing a strategy which is in line with BCRRE's overall position.

## 6. *Identify Information Sources*

The following two activities are related to identifying the sources that will inform the decisions in the strategy, comprising both domain experts and source information. These activities are the responsibility of the Planner role, which decides and organises how the strategy will be designed. As a reminder, the Planner role does not have to be performed by a different *person* to the Design Manager role; the titles simply reflect the different responsibilities.

### a. Identify Experts

Any strategy requires input from domain experts. The knowledge and experience of these people are vital for guiding future activities for the organisation or system. This activity identifies which experts will be consulted during the Capture process. The experts identified might fulfil a role in the design team, or they may simply be invited to contribute to the work.

**Case Study Application:** In order to develop the BCRRE strategy, a number of domain experts will be called upon. BCRRE module leads and teaching staff will assist with shaping the Education theme. Research leads and research staff will contribute to the Research part of the strategy. Students and funding bodies will assist with designing the Education and Research strategy themes. Administrative staff will be consulted in developing the Operations & Processes and People & Organisation parts of the strategy. Finally, an external consultancy will be used to advise BCRRE on the Customers & Markets part of the strategy.



## b. Identify Other Sources

In addition to input from domain experts, other sources provide a valuable input to informing decisions in the strategy. This activity is concerned with identifying relevant information that will be consulted when capturing the strategy. Likely information sources include, but are not limited to:

- Related strategies (to which this strategy must be aligned)
- Previous versions of this strategy (whose content should be considered)
- Standards
- Reports
- Studies
- Statistics

**Case Study Application:** The context diagram was used to identify other source information that will inform the strategy. The University of Birmingham and the College of Engineering and Physical Sciences strategies will be studied to ensure that the BCRRE strategy is aligned. Collaborator and Competitor strategies will provide input to the work carried out by the external consultancy in proposing target customer and markets for BCRRE. The Rail Technical Strategy will also inform the direction of BCRRE's Customers & Markets strategy, by identifying potential areas of growth for the industry (e.g., the Digital Railway). A S.W.O.T. Analysis will identify the Strengths, Weaknesses, Opportunities and Threats to BCRRE. Standards will be taken into account to ensure that initiatives proposed in the strategy are compliant. BCRRE annual reviews will inform the strategy by identifying any internal objectives which must be met or abandoned.

## 7. Establish Language Framework

The purpose of this activity is to determine a common vocabulary and definitions that will be used throughout the strategy design. This step is important for ensuring that crucial information is accurately communicated, to reduce the risk of misunderstanding among stakeholders, and to improve the chance of successfully delivering the strategy. Vocabulary which is central to the strategy (e.g., *vision*, *initiative* etc.) should be concisely defined and agreed by the stakeholders so that there is common understanding throughout the project. For the same reasons, the framework should be adopted for any communication of the strategy.

**Case Study Application:** The common language framework adopted for the BCRRE strategy includes the following central definitions:

**Mission** – why BCRRE (or the theme) exists.

**Vision** – where BCRRE (or the theme) is envisioned to be by a defined point in the future.

**Objective** – how BCRRE (or the theme) intends to achieve its vision.

**Initiatives** – what will be done to support the objectives.

A glossary will be included in the published strategy document.

## 8. Plan Decision Making Activities

The final part of the Plan process is to determine how to make the strategic decisions that are central to the strategy. This activity takes into account the identified expert and information sources and explains how they will be used to inform the strategy. Specific tools and techniques should be considered and chosen based on the scale and complexity of the strategy.

**Case Study Application:** The activities that will support decision making for the BCRRE strategy are: document analysis of the identified sources, a S.W.O.T. analysis, and workshops with identified experts. A clear link will be maintained between all decisions that are made and their source. Once each part of the strategy has been developed, they will be brought together

into one complete piece of work. Checks will be made to ensure that background information and justification for each decision is clearly shown.

End

At the end of the Plan process, a strategy design plan will have been produced. This could be presented as a formal document or it might equally be a simple mental record. When the process has been completed, the Capture process can be started.

**Case Study Application:** The Design Manager (Head of Development) confirms that each activity in the Plan process has been completed through the use of a simple checklist.

## 5 Capture Process

### 5.1 Overview

The second of the strategy design processes is the Capture process. The purpose of this process is to capture the information which constitutes the strategy by carrying out the activities planned during the Plan process. The process determines *where* the organisation or system is envisioned to be in the future, *how* this will be pursued, and *what* activities will contribute. It includes some decision points, where parts of the process should be repeated, if necessary. At the end of the process, the user will have captured the strategy that was sought at the beginning of the exercise. The captured information can then be used to communicate the strategy as required. Figure 36 shows the order of the activities which make up the process and the role responsible for each. The process begins at the black circle and is completed when the user reaches the 'polo' shaped circle at the end of the sequence. The activities and stakeholder roles will be explained in further detail below. Examples and references to additional resources are provided in the Guidance document in the Appendix.

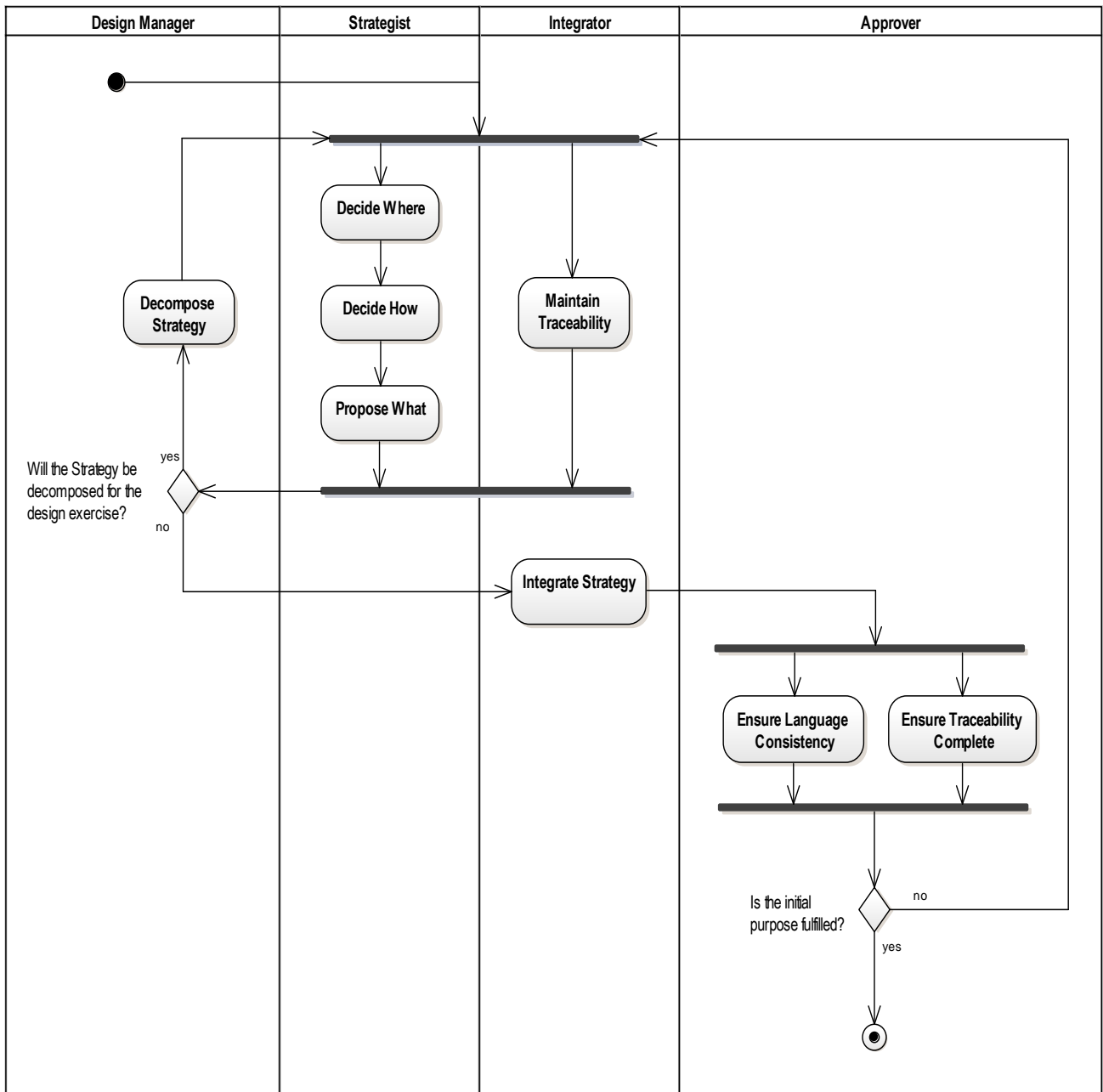


Figure 36 – Overview of the strategy design Capture process (author, 2015)

## 5.2 Stakeholders and Roles

In addition to the Design Manager role, three main roles are responsible for capturing the strategy. These are:

- The **Strategist** – makes strategic decisions based on input from experts and information sources, using appropriate tools and techniques.
- The **Integrator** – brings together the component parts of the strategy and ensures that traceability is maintained.
- The **Approver** – approves the strategy at different stages of its capture, including the final approval.

Although four different *roles* are responsible for capturing the strategy, this does not necessarily equate to four individual *people*. For example, the Strategist and the Integrator roles may be performed by the same person. It should also be remembered that the name of the role does not relate to a particular job title, but rather describes the role held during this process. For example, the Strategist role does not need to hold the title of *Strategist* in the organisation.

### 5.3 Capture Activities

#### 1. Start

Before starting the Capture process, all activities in the Plan process should have been completed.

**Case Study Application:** The Design Manager (Head of Development) has checked that each activity in the Plan process has been carried out and agreed that the Capture process can be started.

#### 2. *Decision Making and Traceability*

The first set of activities is related to the principal decisions that will be captured in the strategy: *where* the organisation or system is envisioned to be in the future, *how* this will be pursued, and *what* activities will contribute. As explained previously, this guidance is not intended to replace recognised techniques and processes for strategic decision making. As such, the following three activities depend on the experts, information sources, and decision

making approaches identified during the Plan process. Further direction is provided in the additional resources for each of activity listed in the Guidance document. The relationships between decisions must be clearly demonstrated (traceability).

#### a. Decide Where

The first strategic decisions to be captured relate to where the organisation or system is envisioned to be by a defined point in the future (as set by the scope). This is often called the *vision*, but may be known by a different name. Whichever name is chosen should have been defined during the Plan process and be used consistently throughout the work. The tools and techniques that will assist with this activity will also have been determined during the Plan process.

**Case Study Application:** The following sources were taken into account in determining BCRRE’s vision: the Centre’s Mission Statement, the University of Birmingham strategy, the Rail Technical Strategy, and Network Rail’s *A Better Railway for a Better Britain*. BCRRE’s overall vision is established as ‘to be *the largest and most influential University based Railways Centre in Europe, delivering academic excellence internationally by educating the railway leaders of tomorrow and conducting transformational research for the railway leaders of today.*’ A number of more specific visions are also established.

#### b. Decide How

After stating where the organisation or system should be by a certain point in time, the next step is to capture *how* this will be achieved. This is often called the *strategy*, but may be known by any name. Whichever name is chosen should have been defined during the Plan process and be used consistently throughout the work. The tools and techniques that will assist with this activity will also have been determined during the Plan process. The *how* information must be linked to the *where* information decided in the previous activity.

**Case Study Application:** Objectives are identified which set out how BCRRE will achieve the established visions. The list of objectives is presented in a table, with explicit links between each objective and its related vision. The visions and Objectives are given unique reference numbers.

#### c. Propose What

Finally, once it has been determined *where* the organisation or system should be by a certain point in time and *how* this will be reached, suggestions for *what* specific activities to initiate might be proposed. These decisions are often called *initiatives or plans*, but may be known by any name. Whichever name is chosen should have been defined during the Plan process and be used consistently throughout the work. This activity is not compulsory at this stage; if the strategy is not intended to be overly prescriptive, it may instead be carried out once the strategy is completed, during delivery. The Plan process will have determined whether this activity will be carried out, and if so, identified the tools and techniques that will assist it. If the activity is performed, the *what* information must be linked to the *how* information decided in the previous activity. If specific activities are proposed, it is useful to name a responsible stakeholder and to suggest an expected deadline.

**Case Study Application:** A high level plan is presented which proposes certain initiatives and identifies the stakeholder role responsible. The plan was conceived following workshops with relevant groups of BCRRE members. Each initiative is given a unique reference and linked to its related objective, which is in turn linked to an overall vision.

#### d. Maintain Traceability

The purpose of this activity is to ensure that the relationships between strategic decisions are captured and clearly illustrated. This concept, known as traceability, is usually associated with systems engineering or requirements management activities, and is not traditionally applied to designing strategy. However, the benefits of ensuring traceability are equally relevant to strategy design. Traceability can demonstrate how a change to one part of the strategy might

affect other areas. It also enables the justification of decisions by identifying the source, and demonstrates the impact that changes to high level decisions can have on the whole system.

Traceability should be captured between:

- Related strategies (e.g. the EU White Paper and the Rail Technical Strategy)
- Source information and decisions (e.g. a Rail Technical Strategy *vision* and a key decision made in this strategy)
- Related decisions in this strategy (as shown in Figure 44)

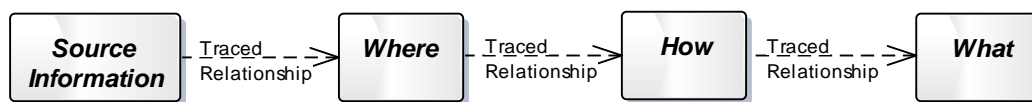


Figure 44 - Traced relationships between strategic decisions (author, 2015)

**Case Study Application:** Each decision made in the BCRRE strategy is carefully aligned with its source and with related decisions. In addition to the tables provided in the BCRRE Strategy Information appendix, the links between decisions are also mapped in a central model, which is planned to be made available in the online resource. A view of the model is provided to demonstrate how important decisions can be justified and change impact can be assessed. In addition, the model illustrates how the planned initiatives for the Centre are aligned with external strategies, such as the Rail Technical Strategy.

Q: Will the Strategy be decomposed for the design exercise?

Once strategic decisions have been made regarding the overall strategy, the strategy may be decomposed into individual areas, such as Rolling Stock or Infrastructure. This activity will have been determined during the Plan process. If the strategy will not be decomposed (which may be the case for a smaller scope of work), the subsequent activity can be started.



**Case Study Application:** The BCRRE strategy is broken down into five, more specific areas: Education, Research, Customers & Markets, Operations & Processes, and People & Organisation. Visions, objectives and initiatives are established for each area in line with those already set out for the whole of BCRRE.

### 3. Decompose Strategy

If the strategy will be decomposed, this should be carried out in accordance with the work breakdown established during the Plan process. Subsequently, the first activities of the Capture process should be repeated for each individual area in the strategy. Traceability should always be maintained between the decisions made for the overall strategy and those made for the individual areas. For example, there should be a clear link between the *visions* for Rolling Stock and those for the overall strategy.

**Case Study Application:** BCRRE's overall visions, objectives and initiatives are considered in developing the detailed sections of the strategy. A matrix shows which overall visions, objectives and initiatives are relevant to each theme. The table shows that even where a particular vision appears to be unrelated to a theme, there might be specific initiatives linked to that vision which are relevant. The visions, objectives and initiatives identified as relevant are taken into account when developing each section of the strategy. Other sources which informed these decisions were related documents, workshops and the S.W.O.T. analysis.

### 4. Integrate Component Parts

Once strategic decisions have been made for each of the individual areas, the strategy should be reassembled to form the integrated strategy. This is an important part of the process which will ensure that the final strategy is robust and sufficiently traceable.

**Case Study Application:** Once the five detailed sections of the strategy are completed, they are assembled to produce the whole strategy. A diagram is provided in the BCRRE Strategy Information appendix, showing an overview of the composition of the strategy.

## 5. Verification

The following activities are designed to ensure that the strategy design process has been carried out correctly, before it is finally approved.

### a. Ensure Language Consistency

A language framework, including a common vocabulary and definitions, will have been established during the Plan process. During this activity, the integrated strategy should be checked against the framework to ensure that the vocabulary is consistent and that it has been used in the correct context. The strategy should be amended until the language used is consistent with the framework specified in the plan.

**Case Study Application:** The vocabulary and definitions set out in the strategy design plan are adhered to throughout the design of the BCRRE strategy. A technical writer ensures that the language used in each section of the strategy is consistent. A glossary is planned to be included in the dissemination of the strategy.

### b. Ensure Traceability Complete

The second check that should be performed is ensuring that the relationships between strategic decisions and their sources have been captured (traceability). The strategy should be amended until all decisions in the strategy can be linked to the respective sources, or the sources themselves should be improved.

**Case Study Application:** Once the separate parts of the strategy are integrated, the links between decisions in each section are incorporated into the overall traceability model. A check is then made to ensure that each initiative set out in the strategy can be justified. A view from the model highlights a missing link between an objective and its source. All missing links are amended to ensure that the strategy is fully traceable.

Q: Is the initial purpose fulfilled?

Finally, the integrated strategy should be checked against the initial purpose determined in the Plan process. If specific measures were agreed with the Client, these can be checked at this point. The strategy should meet the requirements set out by the Client, otherwise the Capture process should be repeated until the initial purpose has been fulfilled.

**Case Study Application:** The initial purpose of the design exercise was to set the five year vision for BCRRE and to determine how the research and education activities of the Centre can best be aligned to achieve this. The Director of BCRRE is satisfied that this purpose has been met and has authorised the completed strategy.

Finish

Once the Client is satisfied, the end of the process has been reached and the strategy is completed. For the strategy to be disseminated, for example in a published document, the Communicate process should be followed to ensure that all mandatory information is included.

## 6 Communicate Process

### 6.1 Overview

The final strategy design process is Communicate. The purpose of this process is to communicate the strategic decisions and supporting information established during the Plan and Capture processes to a specific audience, in an effective manner. A strategy document is one example of how strategic decisions might be communicated. Other methods include oral presentations, online resources and internal reports. The Communicate process should be followed when any form of strategy dissemination is required. At the end of the process, the user will have produced a disseminated strategy. The process can be repeated for each method of dissemination required. Figure 37 shows the order of the activities which make up the process and the role responsible for each.

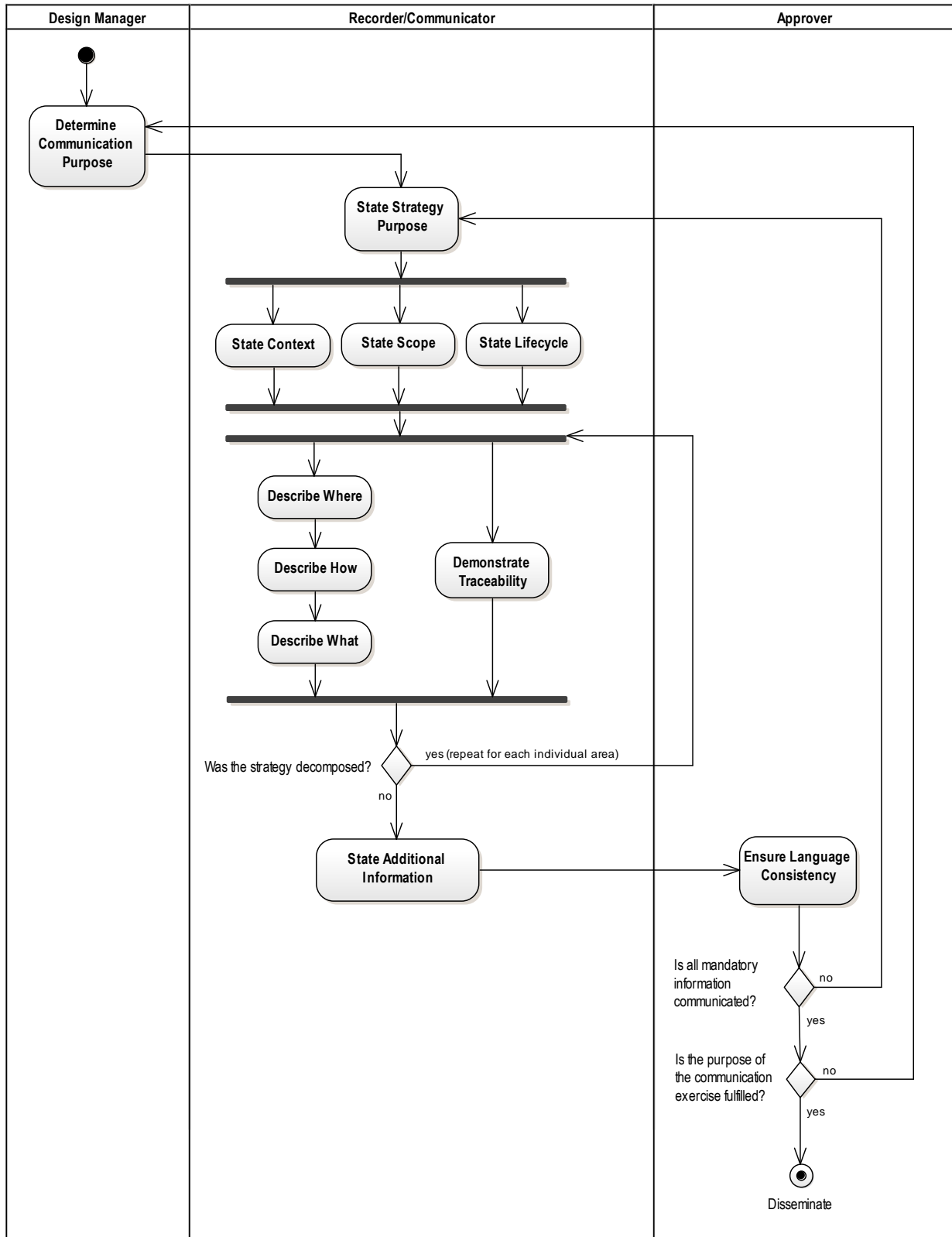


Figure 37 – Overview of the strategy design Communicate process

The process begins at the black circle and is completed when the user reaches the ‘polo’ shaped circle at the end of the sequence. The information required to communicate the strategy to a particular audience will have been produced during the Plan and Capture processes. The processes may be repeated until all concerned stakeholders are satisfied with the final communicated strategy. The activities and team roles will be explained in further detail below. Examples and references to additional resources are provided in the Guidance document in the Appendix.

## 6.2 Stakeholders and Roles

The three main roles responsible for communicating the strategy are:

- The **Design Manager** – agrees the work with the Client, assembles the design team and sets working practices.
- The **Recorder/Communicator** – captures the information produced throughout the process and communicates it to a specific audience.
- The **Approver** – approves the strategy at different stages of its design, including the final approval.

Although three different *roles* are responsible for capturing the strategy, this does not necessarily equate to three individual *people*. For example, the Design Manager and the Approver roles could be performed by the same person. It should also be remembered that the name of the role does not relate to a particular job title, but rather describes the role held during this process. For example, the Recorder/Communicator role does not need to hold the title of *Recorder* or *Communicator* in the organisation.

## 6.3 Communicate Activities

### 1. Start

The Communicate process can be started after or in parallel with the Capture process. The information that constitutes the disseminated strategy will be produced during the Plan and Capture processes.

### 2. Determine Communication Purpose

A strategy may be communicated in various different ways according to the intended audience. For example, the version of a strategy which is presented to the CEO of an organisation is likely to be different to the version which is made available to the public. Before communicating the strategy, it is important to determine the purpose of the communication exercise. The process can be repeated each time a new perspective of the strategy is required. This activity is the responsibility of the Design Manager, who should refer to the strategy design plan for details of the planned types of dissemination.

**Case Study Application:** The purpose of the strategy document is to communicate the new five year strategy for BCRRE. The document is intended for staff, students, industry partners and interested organisations.

### 3. State Strategy Purpose

During the Plan process, the purpose and expected outcome of the strategy design exercise were agreed. This information should be included in all communication of the strategy so that the reader has a clear understanding of what the strategy addresses.

**Case Study Application:** The strategy purpose is taken from the strategy design plan and tailored to suit the audience of the strategy document, without altering the meaning.

### 4. State Strategy Perspective

The following three activities are related to the wider perspective of the strategy. This information was produced during the Plan process and can be communicated in any order.

#### a. State Context

During the Plan process, the strategy was described within its wider context. This information should be included in all communication of the strategy so that the reader understands how the strategy relates to the wider environment.

**Case Study Application:** The context description is copied directly from the strategy design plan into the strategy document, including the BCRRE organisational chart and the context diagram.

#### b. State Scope

During the Plan process, the scope of the strategy was established. This information should be included in all communication of the strategy so that the reader understands the boundaries of the strategy and only necessary work is carried out.

**Case Study Application:** The scope of the strategy is taken directly from the textual description in the strategy design plan.

#### c. State Lifecycle

During the Plan process, the lifecycle of the strategy was described, from the initial instruction to its eventual withdrawal or replacement. This information should be included in all communication to aid the planning of the strategy deliver.

**Case Study Application:** The lifecycle description uses the Gantt chart and accompanying text from the strategy design plan.

### 5. Describe Strategic Decisions and Traceability

The following four activities are related to the decisions captured in the strategy: *where* the organisation or system is envisioned to be in the future, *how* this will be pursued, and *what* activities will contribute. This information was produced during the Capture process and should be communicated in the logical order detailed below.

a. Describe Where

Information related to where the organisation or system is envisioned to be was determined during the Capture process. This is one of the fundamental parts of a strategy; therefore it must be included in its communication.

**Case Study Application:** This section is adapted from the information in the completed strategy and tailored to suit the audience of the strategy document. The BCRRE mission is included, but the table detailing alignment with other sources is omitted. The six main visions are presented alongside only their individual reference number.

b. Describe How

Information related to how the envisioned future of the organisation or system will be achieved was determined during the Capture process. This is one of the fundamental parts of a strategy; therefore it must be included in its communication.

**Case Study Application:** The objectives are communicated as shown in the completed strategy. Each objective is linked to its related vision in a table.

c. Describe What

Information related to what specific activities to initiate may have been determined during the Capture process. This is an optional part of a strategy; so it may not be present in the communication method.

**Case Study Application:** The initiatives are presented in the strategy document as captured in the completed strategy. The high level plan, proposing initiatives and identifying the role responsible, is displayed in a table. The plan was conceived following workshops with relevant groups of BCRRE personnel. Each initiative is linked to its related objective, which is in turn linked to an overall vision.



#### d. Demonstrate Traceability

During the Capture process, relationships between *where*, *how* and *what* information will have been captured. It is important to communicate this information so that those who deliver the strategy understand how specific activities relate to the overall future position of the organisation or system.

**Case Study Application:** This section of the strategy document repeats the information from the Capture process to describe the central model developed for the strategy. Each decision made in this strategy has been carefully aligned with its source and with related decisions in the model, which will be made available in the online resource. An example view of the model is shown with a commentary.

Q: Was the strategy decomposed?

If the strategy was decomposed, the *describe strategic decisions* activities should be repeated for each individual area. If the strategy was not decomposed, the subsequent activity can be started.

**Case Study Application:** Information is included on the five themes of the strategy and their alignment with the overall BCRRE visions, objective and initiatives. The diagram produced in the Plan process is included to provide an overview of the complete strategy.

#### 6. State Additional Information

Some instances of strategy communication may require additional information to the minimum necessary information stated above. This information can assist with marketing the strategy or presenting it in a particular manner. However, it is not critical for effectively communicating the foundations of a strategy.

**Case Study Application:** No additional information is included outside the required information.

## 7. Ensure Language Consistency

During this activity, the communicated strategy should be checked against the language framework established during the Plan process to ensure that the vocabulary is consistent and that it has been used in the correct context. The strategy should be amended until the language used is consistent with the framework.

**Case Study Application:** The vocabulary and definitions set out in the strategy design plan are adhered to throughout BCRRE strategy document. A technical writer is used to ensure that the language used is consistent. The glossary is included at the beginning of the document.

Q: Has all mandatory information been communicated?

Once the strategy has been communicated, it should be checked against the list of mandatory information specified in the Guidance document. The list, which relates to relevant activities in the Communicate process, comprises:

- Strategy purpose
- Strategy context
- Strategy scope
- Strategy lifecycle
- *Where* information
- *How* information
- *What* information
- Whole strategy view
- Traced relationships

If any of the above information is absent from the communicated strategy, the process should be repeated until the strategy is complete.

Q: Has the purpose of the communication exercise been fulfilled?

Finally, the communicated strategy should be checked against the initial purpose of the communication exercise. If specific requirements or constraints were specified, such as page limit, these should be checked at this point. The process should be repeated until the communicated strategy fulfils the original purpose of the exercise.

## Disseminate

At the end of the process, the strategy to be communicated can be disseminated in any way desired. Some strategies will be printed and distributed, other may be disseminated internally via an online platform. Some will be accompanied by promotional initiatives, whereas the dissemination of other strategies might be more subtle. These details will have been determined during the Plan process and when determining the purpose of the specific communication exercise.

## 7 Case Study Evaluation

### 7.1 Methodology

The strategy design processes were followed in an example exercise to design a strategy for the Birmingham Centre for Railway Research and Education. The standalone process guidance document directed and informed the execution of each activity specified in the approach. The execution of each process produced an output which is presented in the Case Study document in the appendices. An explanation of how each activity was carried out is included in this chapter, alongside each activity description. Decisions made throughout the exercise were based on my own experience and preferences, which is representative of a real life situation. For example, I chose to describe the context of the strategy using a model, whereas another user might prefer a textual description. The approach provides for this flexibility. The guidance enabled me to tailor each activity for the specific BCRRE example, with the references providing suggestions for how each activity might be completed. However, there is recognised potential for bias as the case study was carried out by the person who wrote the guidance, and

who is therefore very familiar with the processes. Further trials are recommended to validate the approach with user groups from different domains who are not familiar with the work.

## 7.2 Output

The outputs of the example strategy design exercise were outlines of a strategy design plan, strategy information, and a strategy document. The strategy design plan contains information that is commonly produced during a strategy design exercise but not always captured. The strategy information represents the information produced that is commonly captured in a published document. The strategy document comprises the minimum information from *both* the Plan and Capture processes that should be disseminated in order to ensure the effective communication of a strategy.

In Chapter 4, existing strategy documents from the railway domain were evaluated for alignment with systems engineering principles. Requirement RA1.3 for the design approach states that the process model shall be aligned with those principles. To assess whether this requirement has been met, the outline strategy document produced in the case study exercise has been evaluated using the scoring system established in Chapter 4. The results of the evaluation are shown below.

**Table 12 - BCREE Strategy scores for alignment with SE principles**

Document: BCRRE Strategy		
Principle	Score	Justification
<b>Planning</b> Deciding and stating how the strategy will be designed.	1	Although a detailed strategy design plan has been produced, there is limited evidence of this in the final disseminated strategy document. Some information is included on decision making sources.
<b>Lifecycle</b> The whole life of the strategy, from understanding the purpose of the exercise, to publishing and eventually withdrawing or replacing the strategy.	2	The lifecycle of the strategy is mentioned and compared against the lifecycles of other related strategies.
<b>Context</b> How the strategy is related to its wider environment	2	The strategy document includes a context diagram, showing which other strategies are related and how they will be used to inform the strategy.

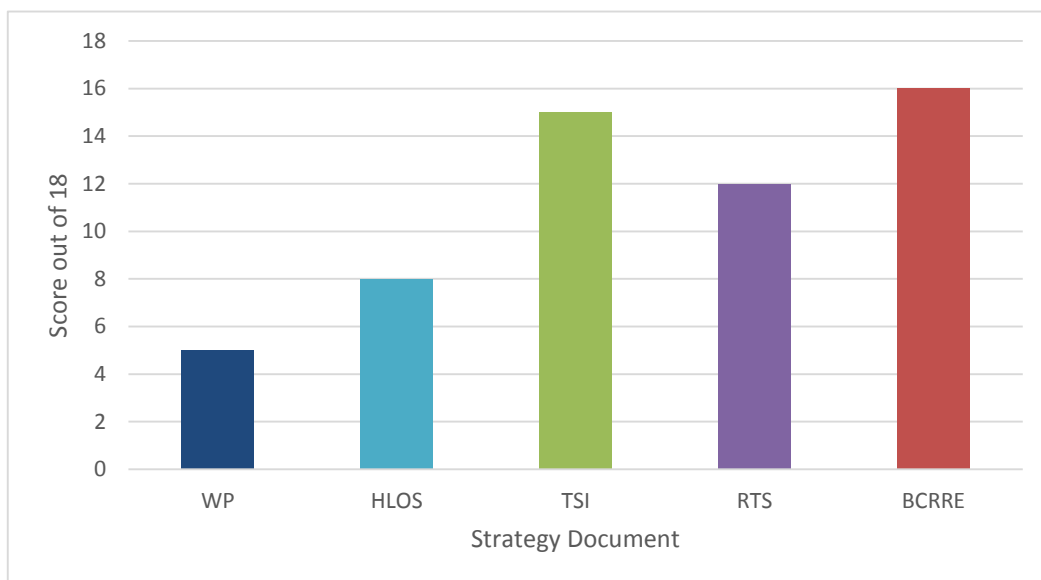
<b>Understanding the Problem</b> Why the strategy is being designed and the expectations of stakeholders.	2	The purpose of the strategy is described. The needs of the Engineering College and University of Birmingham are taken into account.
<b>Requirements Definition</b> The quality of the requirements included in the strategy.	2	The visions in the document are displayed in a table with reference numbers. The statements are singular and written in a consistent manner.
<b>Decomposition &amp; Integration</b> The appropriate partitioning of the strategy and the subsequent integration of the individual areas into a whole strategy.	2	The document describes the division of the strategy into five themes which are aligned with the BCRRE overall position. An overview diagram of the complete strategy is provided.
<b>Traceability</b> The explicit linking of key information in the strategy.	2	The visions are linked to the related objectives and initiatives using a coding system. Reference is made to a model which contains detailed links between key information and the sources.
<b>Verification &amp; Validation</b> Determining how well the strategy design process has been carried out and whether the final strategy fulfils the intended purpose.	1	The strategy fulfils the purpose set out and includes the minimum information specified in the Communication process. Generally, however, v&v decisions during the processes are not captured in the document.
<b>Language</b> Establishing a consistent language framework.	2	The document includes a glossary of the key vocabulary used in the strategy. The language used is consistent with the glossary provided.
Total	16/18	

The draft BCRRE strategy document scored well on the systems engineering evaluation, with 16 out of 18 possible points. This demonstrates that the systems engineering principles identified in Chapter 4 have largely been incorporated successfully into the strategy design approach developed in this work. However, the cyclical and potentially biased nature of the evaluation, which was carried out by the same person who conducted the case study, is openly acknowledged. It is recommended that the evaluation be repeated for strategy documents produced by other people having followed the approach. It would also be beneficial to identify more specific, measurable indicators of SE alignment for future evaluations.

If the evaluation had taken into account the whole strategy design process rather than simply the Communicate process output document, the BCRRE strategy design process would have scored the maximum available points. The *planning* and *verification & validation* principles are well evidenced in the outputs of the Plan and Capture processes, but not communicated in the disseminated strategy document. This shows that a strategy document provides only one

view of the whole strategy design process. Those who are expected to deliver the strategy successfully should be provided with an appropriate view of the strategy, not simply the view that is publically disseminated.

Figure 45 shows that the draft BCRRE strategy document performed better than the four documents evaluated in Chapter 4. Remembering the general correlation between alignment with SE principles and user satisfaction, it would be expected that users would find this document to be of a high quality and easy to use. This hypothesis would require further exploration in future work.



**Figure 45 - Comparison of SE alignment in BCRRE and existing strategies**

## 8 Summary

I presented the strategy design processes in a model in Chapter 5 and have provided a description in text form in the present chapter. The detailed guidance and example case study provided in the Appendix complete the approach. The case study allowed me to demonstrate how the theoretical strategy design processes might be practicably implemented in a real scenario. By completing each activity in the case study, three outputs were produced: a strategy design plan, outline strategy information, and an outline strategy document. The strategy

document was produced by selecting relevant information that had already been captured during the Plan and Capture processes. This approach ensures that the strategy design exercise is focussed on producing the right information, rather than creating a specific document. As shown in the case study, the information communicated in a strategy document is likely to represent only a subset of all the information produced throughout the exercise. The strategy design approach produces a model of the whole strategy, which can be communicated subsequently as any number of views, depending on the purpose.

The application of the strategy design approach in this example demonstrated how the activities might be carried out for a medium sized enterprise wishing to develop a short term strategy. Further case studies are recommended to test the validity of the approach in other scenarios. Each case study requires a good knowledge of the organisation and the strategy being developed. Likewise, it would be valuable to test the usability of the approach guidance on a number of different user groups. Future work would include a series of trials to further test the approach.

# CHAPTER 7

## CONCLUSIONS

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### 1 Overview

Strategy is fundamentally concerned with how best to direct systems in a changing world. As businesses and organisations today become increasingly complicated and complex, traditional hierarchical approaches to strategy design are less relevant and more holistic approaches are being sought. Although systems thinking has long been valued in the making of strategic decisions, my work has illustrated that it is often neglected in whole strategy design. The literature review highlights a recognised link between effective communication and the successful delivery of strategies. However, existing strategy documents are shown to vary considerably in perceived quality and usability. Furthermore, I have indicated a positive correlation between how well documents are aligned with systems engineering principles and the resulting level of user satisfaction. Taking these factors into account, I have researched, developed and evaluated a formalised systems approach to strategy design.

The proposed approach comprises a model, a textual description, a standalone guidance document, and a case study. The approach was developed using the Seven Views process modelling framework and the Unified Modelling Language. Requirements for the approach were elicited from the literature review, the British railway case study, and the evaluations of existing strategy documents. The resulting requirements informed the development of the seven views of the strategy design model. The Plan, Capture and Communicate processes which I have defined are explained in detail in a textual description. An example case study was used to illustrate one application of the approach and to provide a level of verification. In the following section, I evaluate the approach against the original set of requirements.



Figure 46 illustrates the systems engineering approach that I adopted in carrying out this research.

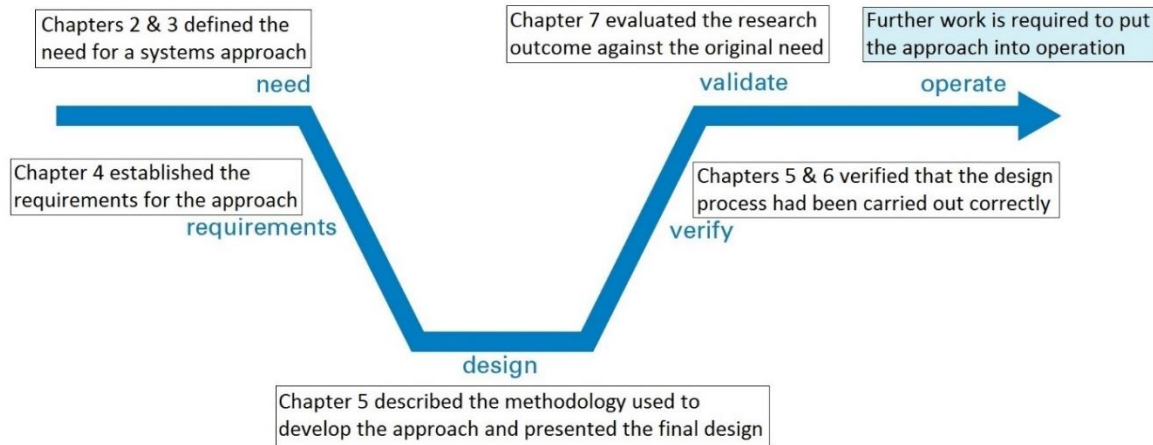


Figure 46 - V lifecycle model, adapted from (INCOSE UK, 2009)

## 2 Evaluation of the Approach

### 2.1 Against the Requirements

In Chapter 4, I defined a set of requirements for the strategy design approach by amalgamating the statements identified in the previous chapters. In line with systems engineering practice, I have evaluated the approach against these requirements to ensure that it has been developed correctly. The following table shows whether each of the original requirements has been satisfied and provides a justification for each decision.

**Table 13 - Evaluation against the requirements defined for the approach**

Req. #	Text	Req. satisfied	Justification
RA1	The approach shall include a process model.	Yes	The process model is presented in Chapter 5.
RA1.1	The process model shall be generic.	tbd	The process model has been designed to be suitable for any domain. Further trials are required across a range of domains and hierarchical levels of strategy. (medium term)
RA1.2	The process model shall be holistic.	Yes	The model has been developed using a holistic process modelling framework showing seven views of a process. The activities in the model relate directly to SE principles.
RA1.3	The process model shall be aligned with systems engineering principles.	Yes	The activities in the model are traceable to the SE principles identified.
RA1.4	The process model shall apply the defined terminology.	Yes	The terminology defined in Chapter 2 is applied throughout the process model.
RA2	The approach shall include strategy communication.	Yes	Strategy communication is included as a whole process and is an integral part in many of the activities.
RA2.1	The approach shall support effective communication.	Yes	The approach stipulates the creation of a language framework, to ensure that communication is consistent and clear. The traceability activities encourage the clear presentation of information relationships.
RA2.2	The approach shall support the use of any communication tool.	Yes	The Communicate process can be repeated for any form of dissemination required. The approach does not focus on the creation of a strategy document, but rather on producing the information that contributes to it.
RA3	The approach shall include guidance.	Yes	Detailed guidance is included in the Appendix.
RA3.1	The guidance shall use the defined terminology.	Yes	The guidance strictly adopts the terminology defined in Chapter 3 and in the model.
RA3.2	The guidance shall reference model-based communication.	Yes	The guidance encourages the consideration of model based approaches throughout the processes. Further references are provided.
RA3.3	The guidance shall reference natural language communication.	Yes	The guidance provides advice on communicating clearly in natural language. Further resources are discussed.
RA3.4	The guidance shall cover how to produce a strategy document.	Yes	The Communicate process describes how to produce a strategy document from the information produced during Plan and Capture.
RA3.5	The guidance shall be easy to use.	tbd	Requires further trials with individuals who are unfamiliar with the processes. (medium term)
RA4	The approach shall improve the efficiency of strategy design exercises.	tbd	Requires further research to establish measures of efficiency and subsequent trials. (long term)

## 2.2 Further Evaluation

The exercise above shows that 12 out of the 15 original requirements have been satisfied by the approach developed in this work. Requirements RA1.1, RA3.5, and RA4, which are yet to be determined, require further evaluation and are recommended for further work. This includes trialling the approach with impartial individuals, across different domains, and at various hierarchical levels of strategy design.

## 3 Evaluation of the Research Project against the Objectives

The purpose of this research project was to propose a formalised, systems approach to strategy design for complex, multi-stakeholder sectors. I have presented a logical, consistent approach which can now be refined and validated through further work. In the following section, I will describe how the work presented in this thesis responds to the research objectives established in Chapter 1.

### 3.1 What does *strategy* mean?

In Chapter 2, I reviewed and unravelled different interpretations of the word *strategy* evident in existing literature. The foundations of linguistic theory were examined to understand how a single term can signify a number of different concepts, depending on the context and perspective. Seven concepts associated with the word *strategy* were proposed and described. The relationships between strategy processes, strategic decisions, strategy information, and strategy documents subsequently formed the foundations of the strategy design approach.

### 3.2 What is strategy design?

In Chapter 2, I identified and named two groups of strategy processes: *strategy design*, which produces strategy information including strategic decisions, and *strategy delivery*, which puts these decisions into practice. Strategy design, which I differentiate from *strategy formation*, *development*, or *making*, encompasses the whole life of a strategy, from inception to replacement or removal. In Chapters 5 and 6, I presented a detailed interpretation of the activities, information and stakeholders which form the strategy design processes.

### 3.3 Why are current approaches to strategy design insufficient?

I identified and discussed current approaches to strategy design in the literature review and in the railway system case study. I did not find a single, formalised approach which is adopted universally across sectors, or even within the railway industry. Furthermore, the approaches that do exist tend to focus on the decision making aspects of strategy design. Minimal guidance is available for designing a whole strategy from its initiation to its dissemination. Finally, I noted that the importance of effective communication is considered as an afterthought in many approaches, often only highlighted as an issue during strategy delivery. The approach which I have developed provides pragmatic guidance that focusses on effective communication throughout the whole lifecycle of strategy design.

### 3.4 What challenges do complex sectors face in designing strategy?

In the literature review, I discussed the challenges faced by complex and complicated systems of systems, where decisions are made by multiple stakeholders and commonly communicated through strategy documents. In Chapter 3, I described the British railway system as a prominent example of such sectors, examining its structure and decision making processes. I discussed present efforts at a European Union level to impose a similar structure across the whole European railway system. As such constructs become increasingly common in modern society, the British railway example serves to demonstrate the potential successes and failures of complicated and complex systems. The perceived benefits of a systems approach to strategy design in the railway system case study are equally relevant to similarly complicated and complex sectors.

### 3.5 How can systems thinking help to address these challenges?

In the literature review, I discussed the historical influence of systems thinking on strategic decision making. Although systems engineering is typically applied in developing systems, I question why it cannot be equally beneficial earlier in the lifecycle. In Chapter 4, I showed that there are a number of principles which can be translated from the technical SE domain to

strategy design. When existing strategy documents were evaluated by users, those demonstrating alignment with these systems engineering principles were perceived to be better communicated. In Chapter 5, I presented a new strategy design approach that is aligned with the systems engineering principles identified. In the approach guidance, I proposed the use of model based techniques from the systems engineering domain to communicate strategy more effectively.

## 4 Contributions to Knowledge

This research project has allowed me to identify a number of issues that hinder the effective design of strategies. In my thesis, I have made recommendations that should be of benefit to both the fields of strategy design and systems thinking.

### 4.1.1 The strategy design approach

The principal contribution resulting from my research is the proposed systems approach to designing strategy. The model presented in Chapter 5 gives the structure of the strategy design processes, which are further explained in the textual description in Chapter 6. I have also produced a standalone guidance document and accompanying case study, which are included in the Appendix. This work contributes to those responsible for carrying out strategy design exercises, from individuals to multinational corporations.

### 4.1.2 Identification of research gaps

As discussed, the literature review revealed a great deal of research in the fields of systems thinking and strategy theory. However, I also showed that only limited pragmatic guidance is available for designing a whole strategy, not solely the decision making aspects thereof. Furthermore, in the guidance that is available, there is minimal reference to the benefits of systems approaches to whole strategy design. This work contributes to the academic community by identifying areas of potential future research.

#### 4.1.3 Definition of strategy concepts

Many of the literature references comment on the ambiguous nature of the word *strategy* and its subsequent imprecise use. In light of this fact, I have explicitly defined and described seven interpretations of *strategy* for the purpose of this work. These interpretations have been adopted in the thesis and are integral to the strategy design approach. This work contributes to the field of strategy by acknowledging that numerous interpretations of the word *strategy* exist in relevant literature, and by providing a framework for commonly inferred concepts.

#### 4.1.4 Strategy document evaluation

In Chapter 3, I undertook a user evaluation of four sample strategy documents. The results provided an indication as to which documents were perceived to be of the highest quality and which were the most usable. This work contributes to the field of strategy by reporting the opinions of individuals with diverse professional backgrounds. The analysis of the content and structure of each document in Chapter 3 provides an indication as to what constitutes a good quality, useable strategy document.

#### 4.1.5 Systems engineering mapping

In Chapter 4, I presented a tool for evaluating strategy documents based on the INCOSE Systems Engineering Competencies Framework. I mapped the core principles derived from the framework to a strategy design context and suggested how a strategy document might demonstrate alignment with each principle. I later used this tool to evaluate four existing strategy documents and the output of the case study exercise. This work contributes to the systems engineering discipline by demonstrating how SE principles might be manifest in non-traditional domains. It also provides a means for the comparative evaluation of different strategy documents from an SE perspective.

#### 4.1.6 Strategy design outputs for BCRRE

The final contribution of this research is an outline strategy for the Birmingham Centre for Railway Research and Education. While the strategy design exercise was hypothetical, it

responds to a genuine need for the Centre to produce a strategy. The information produced through this work may ultimately benefit the BCRRE leadership in completing this task in future.

## 5 Further Work

### 5.1 Recommendations for researchers

I have identified a number of potential research opportunities through the completion of this research project.

#### 5.1.1 Refine the approach

Although the proposed approach has been refined throughout its development, further enhancement would undoubtedly be required before practical application. Future work would include workshops with multiple user groups to validate the approach in different scenarios and where there is no prior knowledge of the processes. These activities would also contribute to validating Requirement RA3.5, which states that the approach guidance shall be easy to use.

#### 5.1.2 Develop a different approach

This thesis presents only one of many potential approaches to strategy design. I chose to align the approach with systems engineering principles based on my own understanding of the benefits of the discipline. However, other approaches might be developed in a different manner. In developing any approach, it is important to define the *whole life* of strategy design and to emphasise effective communication in the processes.

#### 5.1.3 Assess the influence of this approach on efficiency in strategy design exercises

Requirement RA4 stipulates that the approach presented in this work shall improve the efficiency of strategy design exercises. Without having yet implemented the approach in genuine strategy design scenarios, it is not possible to determine whether the real life efficiency will be improved. A precursor to this potential future work would be to develop

metrics for assessing the efficiency of strategy design and carrying out assessments of current practices.

#### 5.1.4 Further examine the relationship between SE alignment and user perception

This work suggests a positive correlation between user perception of a strategy document and its alignment with systems engineering principles. However, much more research is required in this area to be able to make a substantiated claim. If a positive relationship were to be demonstrated, this would support the belief among the systems engineering community that SE principles can benefit non-traditional domains.

### 5.2 Recommendations for industry

Alongside the potential research opportunities identified, a number of initiatives are suggested for industry.

#### 5.2.1 Trial this approach

The first proposition to industry is to trial the approach presented in this work. Although the processes have been developed using a rigorous, iterative methodology, they have not yet been trialled in a real strategy design exercise. There is still much work required to advance this academic research into a robust, industry-ready approach. A suggested activity would be to organise workshops with stakeholders in different domains.

#### 5.2.2 Consider a formalised approach

Should the approach proposed in this work be found unsuitable, I encourage complex sectors to consider adopting an alternative, universal approach to strategy design, working together where necessary. A single approach adopted across a system of systems would facilitate the integration of different strategies and result in a more whole system view.

#### 5.2.3 Continue efforts to demystify systems engineering

Although there has been much discussion in recent years about extending the influence of systems engineering to non-traditional domains, there is still a lot of work to do in this area.



This includes ensuring that the language is accessible, by simplifying the vocabulary and developing non-technical guidance, and considering removing *engineering* from the title. The strategy design approach proposes certain SE practices, such as modelling and requirements management, translated for a non-engineering domain. Further efforts can be made to interpret relevant practices for other disciplines.

#### 5.2.4 Improve collaboration between systems thinkers and decision makers

Systems thinking has historically played an influential role in strategy theory, and vice versa. Although it is recognised that systems engineering rigour early in the lifecycle can improve the effective communication of important decisions, it is not traditionally applied to communicate strategic decisions. However, the inaccessible language and ideologies of systems engineering can actually alienate the leaders who the SE community is attempting to influence. I recommend improved collaboration between systems engineers and decision makers in order to better understand these different perspectives.

## 6 Final Thoughts

The South African proverb *I am because we are* suggests that our world is formed of many closely interacting parts and that these are meaningless in isolation. Increasingly today, relationships between seemingly unrelated systems are being harnessed to create complex systems of systems. The approach presented in this thesis proposes a systems way of planning, capturing and communicating strategic decisions for those systems. I hope that this work will encourage strategy designers and systems engineers alike to learn from each other's fields and to explore the value in their shared relationships.

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APPENDIX A  
GUIDANCE DOCUMENT

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## Introduction

Strategy is concerned with how best to direct a system in a changing world. As this world evolves, so too must the strategies of organisations and systems that exist within it. A new strategy is often needed in response to new challenges or opportunities that are presented. The approach presented in this document is intended to assist anyone with the task of designing a strategy; that is, creating a strategy from nothing. The document includes step-by-step guidance, examples, and references to additional resources. It is accompanied by a case study demonstrating how the guidance could be used in an example scenario. The approach is not intended to replace original thought, skilled expertise, or recognised existing methods. It does provide pragmatic guidance to competent teams designing strategy. The examples provided are in the context of the railway industry, but the approach is generic and can be tailored according to the individual needs of each user.

## How to use the approach

The guidance document presents the three Strategy Design processes: Plan, Capture, and Communicate. Each process comprises a number of activities which are carried out in a particular order. The activities are shown as a diagram accompanied by explanatory text. The guidance provides for a wide range of scenarios; from an entire team designing a major strategy, to an individual tasked with designing the strategy for a small organisation. Therefore, each activity should be considered and adapted to the specific needs of the user. The guidance also describes the roles necessary for designing a strategy and specifies which role has responsibility for each activity. The accompanying Case Study document demonstrates an example application of the approach for a specific scenario. In many cases, a strategy will be communicated as a formal document. However, it could also take a different form, such as an online resource or oral presentation. The information produced during the Plan and Capture processes will form the content of the chosen form of communication.

## Strategy Design Overview

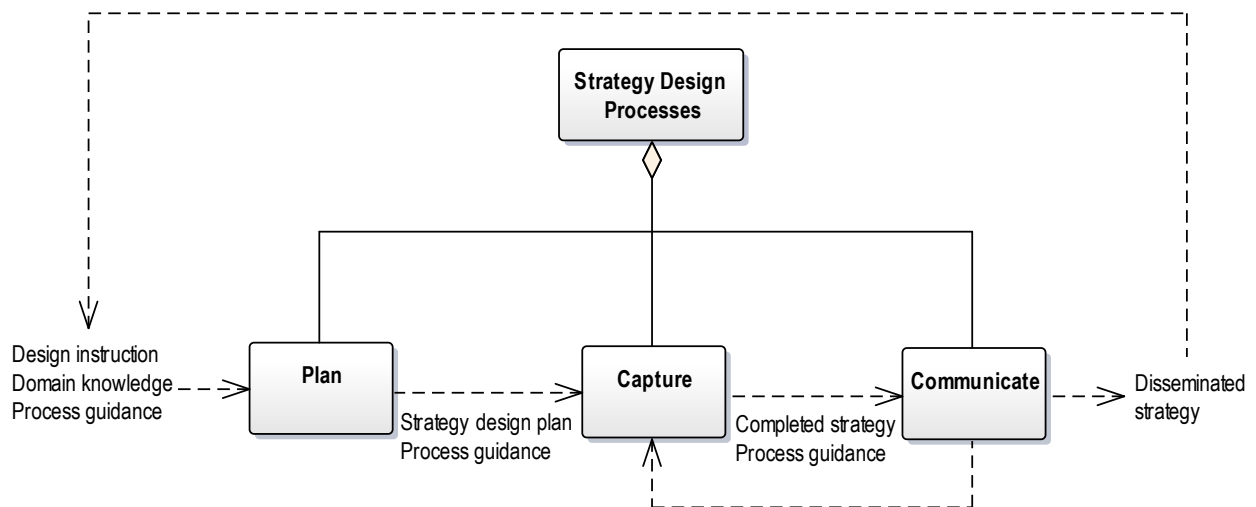


Figure I - Overview of the strategy design processes

Strategy Design comprises three processes: Plan, Capture, and Communicate. Figure I shows an overview of the processes, including information which is transferred from one to another. A strategy design exercise begins with an initial instruction to design a strategy. Combined with domain knowledge and the process guidance, this is the information required to carry out the Plan process. Following this first process, a strategy plan will have been developed, which might be a formal document or simply a mental record. This plan is required to perform the Capture process, alongside the process guidance. The outcome of the Capture process is a completed strategy. Finally, information produced by activities in the Plan and Capture processes will be used in the Communicate process. This final process is used to communicate the strategy to those who will deliver it. The communicated strategy might only contain a selection of the information produced during the planning and capture of the strategy. The three processes will be further explained below, with detailed guidance, examples and references provided for each activity.

# Plan Process

## Overview

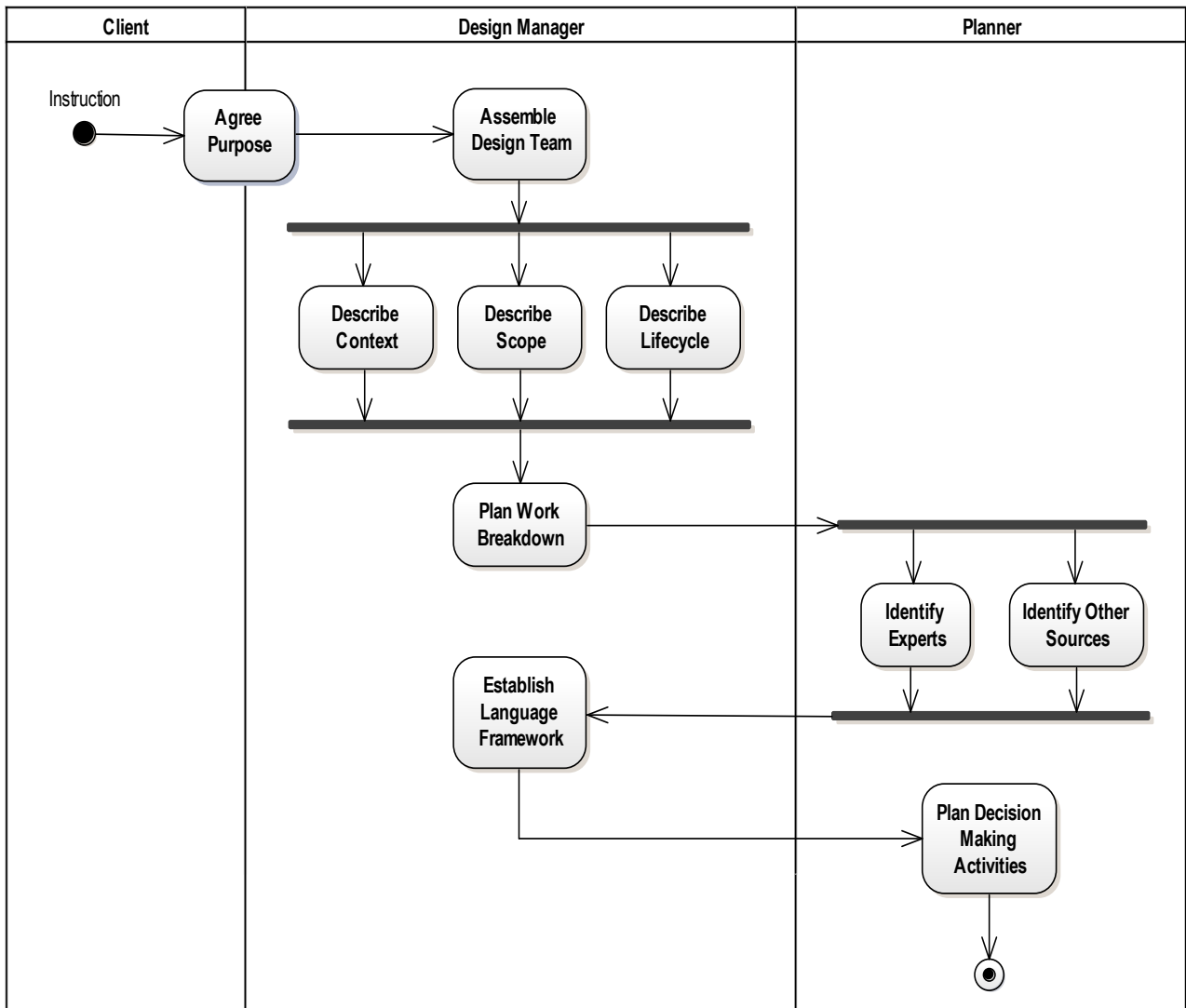


Figure II - Overview of the Plan process

The first of the Strategy Design processes is Plan. The purpose of this process is to plan the activities that will be executed during the Capture and Communicate processes. At the end of the process, the user will have established a plan for capturing and communicating the strategy. The plan might be recorded in a formal document or simply be a mental record. In a small organisation, there may only be one person responsible for developing the strategy. In this case, the Plan process could prompt the individual to adequately plan before hastily designing the strategy. The Plan process includes assembling a team of stakeholders, identifying source information, and planning the specific activities to capture and communicate the strategy. Figure II shows the order of the activities which make up the

process and the role responsible for each. The process begins at the black circle and is completed when the user reaches the 'polo' shaped circle at the end of the sequence. The activities and team roles will be explained in further detail below, including examples and references to additional resources.

## Stakeholder Roles

There are three main roles responsible for planning the strategy. These are:

- The **Client** – requests or initiates the design of the strategy. This role may also finance the work.
- The **Design Manager** – agrees the work with the Client, assembles the design team and organises the workload.
- The **Planner** – decides and organises how the strategy design will be carried out.

Although three different *roles* are responsible for planning the strategy, this does not necessarily equate to three individual *people*. For example, the Design Manager and the Planner roles may be performed by the same person. Likewise, in a very small organisation, it is possible for the Client to be the same person that designs the strategy (for example, the CEO). It should also be noted that the name of the role does not relate to a particular job title, but rather describes the role played during this process. For example, the Design Manager role does not need to hold the title of *Design Manager* in the organisation.

## Plan Activities

### 1. Instruction

The Plan process begins when an instruction to design a strategy has been received. This could take the form of a spoken instruction during a meeting, a government policy document, or even an email.

**Stakeholder role responsible:** Client

**Information produced:** A clear instruction to design a strategy.

### 2. Agree Purpose

Before designing the strategy, it is important to first understand the reason for doing this and the required outcome. Without this step, it would be very difficult to determine whether the work has achieved what was initially required. The responsibility for this activity lies between the Client and the Design Manager roles, to ensure that there is a common understanding. At the end of the design exercise, the Client will measure the success of the work by whether it meets the initial purpose. To reduce the risk of misunderstanding, it is recommended that the



purpose be captured and agreed by both parties. It is also useful to agree specific measures that can be checked to confirm whether the purpose has been met. Once agreed, the Design Manager will be responsible for ensuring that the strategy design team understands the purpose throughout the exercise.

**Stakeholder role responsible:** Client and Design Manager

**Information required:** Design instruction

**Information produced:** Strategy purpose – a clear and concise statement, agreed by both the Design Manager and the Client, describing the purpose of the strategy.

**Example:** *Challenge 2050 is the European rail sector's shared perception of where the rail system could be by 2050* (CER, et al., 2013).

**Guidance:** This activity is related to requirements management, which is the discovery and capture of a customer's needs and expectations. There are many techniques which can help with this activity, including; holding workshops between the Client and Design Manager, studying related documents, producing questionnaires, and requirements modelling. Further resources include: (Kupersmith, et al., 2015), (Holt, et al., 2011), (Alexander & Stevens, 2002). For larger or more complex strategy design exercises, a requirements expert might be valuable at this stage.

### 3. Assemble Design Team

Once the purpose of the design exercise has been established, and before further activities can be completed, the Design Manager must identify and assemble the team that will design the strategy. For a small scope of work, the team may consist of only one person, whereas a bigger exercise might require a whole committee. In addition to the Client and Design Manager roles, the following roles should be identified:

- The **Planner** – decides and organises how the strategy design will be carried out.
- The **Strategist** – makes strategic decisions based on input from experts and information sources, using appropriate tools and techniques.
- The **Integrator** – brings together the individual areas of the strategy and ensures that traceability is maintained.
- The **Approver** – approves the strategy at different stages of its capture, including the final approval.
- The **Recorder/Communicator** – communicates the information produced throughout the process to a specific audience.

In a small organisation, the roles could be performed by the same individual, whereas larger design exercises might require several people in each role. It is likely that the Approver role will be determined by existing governance structures in the organisation.

**Stakeholder role responsible:** Design Manager

**Information required:** Domain knowledge

**Information produced:** A list of the stakeholders that will fulfil the roles required for strategy design.

**Guidance:** This activity is related to the scale and complexity of the strategy exercise and is dependent on the Design Manager's knowledge of the organisation's structure and capability. It is possible for one individual stakeholder to perform more than one role. Likewise, it is not necessary for the stakeholder to hold the title of the role. For example, an *Administrative Assistant* could perform the role of Integrator and Recorder/Communicator.

#### 4. Describe Strategy Perspective

The following three activities are related to describing the wider perspective of the strategy. They provide an important overview of how changes to one strategy might impact other strategies, or even the whole system. The three activities can be completed in any order. Although the Design Manager is ultimately responsible for these activities, they should be carried out in collaboration with the other stakeholders in the process.

**Stakeholder role responsible:** Design Manager

**Information required:** Strategy purpose, Domain knowledge

##### a. Describe Context

Context is related to viewing the strategy as part of a bigger picture and considering its interfaces within the wider environment. The activity includes, but is not limited to:

- Illustrating the strategy within the wider environment
- Considering the broader political, strategic and legal landscape
- Naming strategies which must be taken into account
- Naming strategies which might be affected by this strategy
- Naming standards which must be taken into account
- Describing the purpose or goals of the wider environment
- Identifying stakeholders with an interest in the strategy

**Information produced:** Context Description – A description of the strategy context, which could be a diagram or written as text.

**Example:** The Rail Technical Strategy includes a description of the *Policy and Planning Context* (TSLG, 2012, p. 11).

**Guidance:** This activity requires a good understanding of the position of the strategy within the wider environment and an awareness of other strategies that have been recently developed. A context diagram is a very useful tool for showing these relationships. Information presented as a diagram can be clearer to understand than several paragraphs of text. Many resources are available to provide further guidance on developing a context diagram, such as (Burge, 2011) and (Olsen, 2014). In large, complex strategy exercises, it might be useful to consult a systems engineer for assistance with this activity.

#### b. Describe Scope

Scope is very closely linked to Context, and might even be considered as its inward-facing equivalent. It relates to understanding where the boundaries of the strategy lie, and agreeing what is and is not included in the work. This is an essential step for ensuring that the final strategy covers the required areas, and that only necessary work is carried out. Information which might be considered at this stage includes, but is not limited to:

- Timescale of the vision (e.g. ‘a vision for 2050’)
- Intended audience
- Geographic area
- A particular system of interest (e.g. rolling stock)

**Information produced:** Scope description – A description of the scope of the strategy, which could be a diagram or written as text.

**Example:** *This document is our Strategic Business Plan for England & Wales for the five year period from April 2014 to March 2019* (Network Rail, 2013).

**Guidance:** This activity relies on a good understanding of the purpose of the strategy project, as determined earlier in the process. If the Client and Design Manager agreed a clear and concise description of the purpose, the scope of the project should be relatively easy to determine. However, it is important that the Design Manager clearly communicates this scope to all members of the project team. A diagram can again be a useful tool for showing the boundaries of the strategy and the work which is inside and outside the scope.

#### c. Describe Lifecycle

The third activity related to perspective is the consideration of the lifecycle of a strategy. This means examining the whole life of the strategy, from the initial instruction to its eventual withdrawal or replacement. This activity is important for planning the delivery of the strategy and understanding how it might evolve with time. It includes, but is not limited to:

- Providing historical context for the strategy
- Referencing previous versions
- Suggesting its expected validity
- Specifying details about future versions
- Proposing a time plan for delivery
- Referencing the lifecycle of other strategies

**Information produced:** Lifecycle description - A description of the lifecycle of the strategy, from its initiation to its expected withdrawal.

**Example:** The 2014 Passenger Rolling Stock Strategy describes its historical context in relation to an earlier version and against a timeline of key activities (RSSSG, 2014).

**Guidance:** This activity requires an understanding of the historical context of the strategy, including previous versions and its expected validity. There are many ways to show a lifecycle, from models (INCOSE UK, 2009) to a textual description. A time plan for delivery could be shown as a Gantt chart (Gantt.com, 2012) or similar.

## 5. Plan Work Breakdown

Once the purpose and perspective of the strategy have been determined and the stakeholders assembled, the Design Manager must plan how the work will be apportioned. For a small scope of work, the whole strategy might be designed by one person, whereas a more complex strategy might require several sub-teams. This activity includes, but is not limited to:

- Determining whether/how the strategy will be *decomposed* (for example, it may be divided by discipline, such as Rolling Stock and Infrastructure)
- Planning how the work will be apportioned
- Stating which stakeholder role will be responsible for each activity (for example, there may be five Strategist roles, each working on one section)
- Creating a work plan with deadlines for each activity
- Deciding how the strategy will be communicated

**Information required:** Strategy purpose, List of stakeholders, Perspective information, Domain knowledge

**Information produced:** Work breakdown – A plan of how the strategy will be decomposed and how the work will be apportioned.

**Example:** The Rail Technical Strategy was developed by an expert body made up of senior executive staff, each managing the strategic research for a particular theme (TSLG, 2012).

**Guidance:** This activity requires good project management skills and an understanding of the team's competency. The Design Manager will need to plan a work structure that is appropriate to the scale and complexity of the strategy. There are many tools available to assist with this project management task (Haughey, 2014) (Newton, 2007). It will also be made clear at this point how the strategy will be communicated. This is usually in the form of a document, but it could also be an online resource, a model, an oral presentation, and so forth.

#### 6. *Identify Information Sources*

The following two activities are related to identifying the sources that will inform the decisions in the strategy, comprising both domain experts and source information. These activities are the responsibility of the Planner role, which decides and organises how the strategy will be designed. As a reminder, the Planner role does not have to be performed by a different *person* to the Design Manager role; the titles simply reflect the different responsibilities.

#### **Stakeholder role responsible:** Planner

##### a. Identify Experts

Any strategy requires input from domain experts. The knowledge and experience of these people are required to guide future activities for the organisation or system. This activity identifies which experts will be consulted during the Capture process. The identified experts might fulfil a role in the design team, or they may simply be invited to contribute to the work.

**Information required:** Domain knowledge

**Information produced:** A list of the experts who will be sought to inform the strategy capture.

**Example:** The Rail Technical Strategy acknowledges numerous organisations for their contribution of expertise, from passenger groups to rolling stock technical experts (TSLG, 2012).

**Guidance:** This activity requires a good knowledge of the relevant industry, key organisations, and individuals.

##### b. Identify Other Sources

In addition to input from domain experts, other sources of information provides a valuable input to informing decisions in the strategy. This activity is concerned with identifying relevant information that will be consulted when capturing the strategy. Likely information sources include, but are not limited to:

- Related strategies (to which this strategy must be aligned)

- Previous versions of this strategy (whose content should be considered)
- Standards
- Reports
- Studies
- Statistics

**Information required:** Context description, Lifecycle description, Domain knowledge

**Information produced:** A list of the source information that will be used to inform the strategy capture.

**Example:** The EU White Paper for Transport refers to various studies and reports which informed the strategy, such as the European Deployment plan for ERTMS (European Commission, 2011a).

**Guidance:** The context description produced earlier in the process can assist with identifying other strategies that will inform this work. The lifecycle description can be used to identify potentially valuable information in previous versions of the strategy. There may also be existing reports and studies which should be consulted in this activity. Alternatively, original research might be commissioned especially for this strategy.

## 7. Establish Language Framework

The purpose of this activity is to determine a common vocabulary and definitions that will be used throughout the strategy design. This step is important for ensuring that crucial information is accurately communicated, to reduce the risk of misunderstanding among stakeholders, and to improve the chance of successfully delivering the strategy. Vocabulary which is central to the strategy (e.g. *vision*, *initiative* etc.) should be concisely defined and agreed by the stakeholders so that there is common understanding throughout the project. For the same reasons, the framework should be adopted for any communication of the strategy.

**Stakeholder role responsible:** Design Manager

**Information required:** Domain knowledge

**Information produced:** Language framework – A list of vocabulary and agreed definitions that will be consistently used throughout the strategy.

**Example:** The Rail Technical Strategy includes definitions of the four concepts that are central to the work: *vision*, *objectives*, *strategies*, and *enablers*. A detailed glossary of important terms is also provided (TSLG, 2012).

**Guidance:** This activity should be tailored by the Design Manager in collaboration with the other stakeholders. Any choice of vocabulary can be used throughout the strategy, as long as it is clearly defined and used consistently. Suggestions of commonly-used terms can be found

in other strategies, although they are often used inconsistently. Dictionary definitions can also provide some assistance, as well as strategy theory resources (Hax & Majluf, 1991) (Moore, 1992).

## 8. Plan Decision Making Activities

The final part of the Plan process is to determine how to make the strategic decisions that are central to the strategy. This activity takes into account the identified expert and information sources and explains how they will be used to inform the strategy. Specific tools and techniques should be considered and chosen based on the scale and complexity of the strategy.

**Stakeholder role responsible:** Planner

**Information required:** List of experts, List of source information, Domain knowledge

**Information produced:** A detailed plan of how the strategic decisions will be made.

**Example:** The decision making activities for the Rail Technical Strategy included holding a consultation, whereby members of the rail industry could review and comment on the initial progress (TSAG, 2010).

**Guidance:** The final activity in this process is arguably the most challenging of strategy design. The outcome of this activity will be used to inform the three main strategic decisions: *where* the organisation or system is envisioned to be in the future, *how* it will get there, and *what* will be done to achieve this. Many approaches and tools have been developed to assist with making these decisions; therefore, this guidance does not attempt to reproduce or discount existing work. Instead, strategic decision making activities should be called upon to contribute to strategy design. In this activity, the Planner role will decide which particular decision making tools and process(es) will be adopted. Suggestions include:

- Holding workshops with domain experts and stakeholders
- Identifying related and significant decisions in other strategies
- Forecasting (Hyndman & Athanasopoulos, 2012)
- Systems Analysis (Quade, 1972)
- S.W.O.T. Analysis (Goodrich, 2015)
- Porter's Five Competitive Forces (Porter, 2008)

Alternative methods may exist that are more suitable to the scale and complexity of certain strategies. Many further resources are available in the area of strategic decision making, including: (Hax & Majluf, 1991) (Collins & Porras, 1996) (Olsen, 2010) (Brown, 2012) (Lavinsky, 2013). The Planner should consider the options available and choose the approach

that is best suited to the particular strategy. It may be valuable to solicit the help of a professional strategist at this stage.

End

At the end of the Plan process, a strategy design plan will have been produced. This could be presented as a formal document or it might equally be a simple mental record. When the process has been completed, the Capture process can be started.

## Capture Process

### Overview

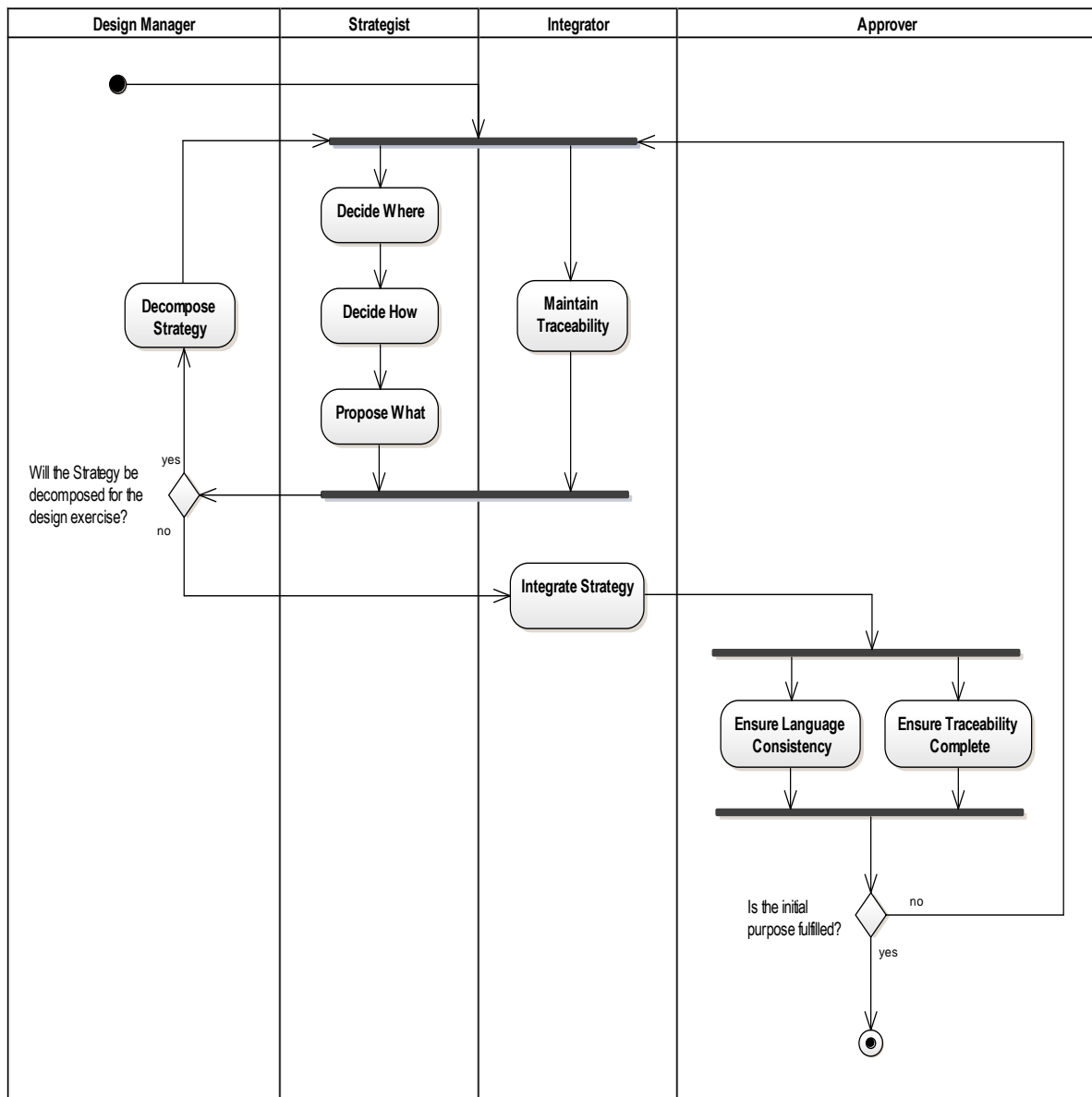


Figure III - Overview of the Capture process



The second of the Strategy Design processes is the Capture process. The purpose of this process is to capture the information which constitutes the strategy by carrying out the activities planned during the Plan process. The process determines *where* the organisation or system is envisioned to be in the future, *how* this will be pursued, and *what* activities will contribute. It includes some decision points, where parts of the process should be repeated if necessary. At the end of the process, the user will have captured the strategy that was required at the beginning of the exercise. The captured information can then be used to communicate the strategy as required. Figure III shows the order of the activities which make up the process and the role responsible for each. The process begins at the black circle and is completed when the user reaches the 'polo' shaped circle at the end of the sequence. Ideally, strategy Capture should only be started once the Plan process has been completed. The activities and stakeholder roles will be explained in further detail below, including examples and references to additional resources.

## Stakeholder Roles

In addition to the Design Manager role, three main roles are responsible for capturing the strategy. These are:

- The **Strategist** – makes strategic decisions based on input from experts and information sources, using appropriate tools and techniques.
- The **Integrator** – brings together the component parts of the strategy and ensures that traceability is maintained.
- The **Approver** – approves the strategy at different stages of its capture, including the final approval.

Although four different *roles* are responsible for capturing the strategy, this does not necessarily equate to four individual *people*. For example, the Strategist and the Integrator roles may be performed by the same person. It should also be remembered that the name of the role does not relate to a particular job title, but rather describes the role held during this process. For example, the Strategist role does not need to hold the title of *Strategist* in the organisation.

## Capture Activities

### 1. Start

Ideally, the Capture process should only be started once all the activities in the Plan process have been completed.

**Stakeholder role responsible:** Design Manager

**Guidance:** The Design Manager should check that all the activities in the Plan process have been sufficiently completed before instructing the team to begin capturing the strategy. One way to facilitate this activity is to produce a check list for the Plan activities and only proceed once each one is marked as complete.

## 2. *Decision Making and Traceability*

The first set of activities is related to the principal decisions that will be captured in the strategy: *where* the organisation or system is envisioned to be in the future, *how* this will be pursued, and *what* activities will contribute. As explained previously, this guidance is not intended to replace recognised techniques and processes for strategic decision making. As such, the following three activities depend on the experts, information sources, and decision making approaches identified during the Plan process. Further guidance is included in the additional resources for each of the activities. The relationships between decisions must be clearly demonstrated (traceability).

**Stakeholder role responsible:** Strategist, Integrator

**Information required:** Strategy design plan

### a. Decide Where

The first strategic decisions to be captured relate to where the organisation or system is envisioned to be by a defined point in the future (as set by the scope). This is often called the *vision*, but may be known by a different name. Whichever name is chosen should have been defined during the Plan process and be used consistently throughout the work. The tools and techniques that will assist with this activity will also have been determined during the Plan process.

**Information required:** Strategy design plan

**Information produced:** *Where* information – Clear and concise statements describing where the organisation or system is envisioned to be by a defined point in the future (as set by the scope).

**Example:** One of the European Commission’s core visions is to *grow Transport and support mobility while reaching the 60% emission reduction target by 2050* (European Commission, 2011a).

**Guidance:** This first decision is related to the envisioned future of the organisation or system addressed by the strategy. This activity alone might take a considerable amount of time and comprise a number of different activities (e.g. workshops, systems analysis, document analysis etc.) The Plan process will have determined which techniques and tools are the most suitable to the scale and complexity of the strategy, and the timescale of the strategy will have been

defined in the scope. All the planned activities should be carried out until the project team has a common agreement of where the organisation or system is envisioned to be at the date set in the scope.

#### b. Decide How

After stating where the organisation or system should be by a certain point in time, the next step is to capture *how* this will be achieved. This is often called the *strategy*, but may be known by any name. Whichever name is chosen should have been defined during the Plan process and be used consistently throughout the work. The tools and techniques that will assist with this activity will also have been determined during the Plan process. The *how* information must be linked to the *where* information decided in the previous activity.

**Information required:** Strategy design plan, *where* information

**Information produced:** *How* information – Clear and concise statements describing how the organisation or system will reach its envisioned future position.

**Example:** *The Government’s strategy for CP5 is built around a rolling programme of electrification, making continued use of ‘cascaded’ modern electric rolling stock and exploiting synergies between schemes in order to efficiently meet forecast demand growth, support economic growth and better environmental outcomes, and secure cost efficiencies for both passenger and freight operators* (Department for Transport, 2012b).

**Guidance:** The second strategic decision to be captured is *how* the organisation or system will reach its envisioned future position. Again, this activity might take a considerable amount of time and comprise a number of different activities (e.g. workshops, Porter’s Five Forces etc.) It might also be useful to consider the progress made since any previous versions of the strategy and to identify challenges which stand between the current position and the envisioned position. The Plan process will have determined which techniques and tools are the most suitable to the scale and complexity of the strategy. All the planned activities should be carried out until the project team has a common agreement of how the envisioned future position will be reached.

#### c. Propose What

Finally, once it has been determined *where* the organisation or system should be by a certain point in time and *how* this will be reached, suggestions for *what* specific activities to initiate might be proposed. These decisions are often called *initiatives or plans*, but may be known by any name. Whichever name is chosen should have been defined during the Plan process and be used consistently throughout the work. This activity is not compulsory at this stage; if the strategy is not intended to be overly prescriptive, it may instead be carried out once the strategy is completed, during delivery. The Plan process will have determined whether this

activity will be carried out, and if so, identified the tools and techniques that will assist it. If the activity is performed, the *what* information must be linked to the *how* information decided in the previous activity. If specific activities are proposed, it is useful to name a responsible stakeholder and to suggest an expected deadline.

**Information required:** Strategy design plan, *how* information

**Information produced:** *What* information – Suggestions for the specific activities that can help to reach the envisioned future position of the organisation or system.

**Example:** The Rail Technical Strategy includes a number of specific *actions* to help deliver its innovation *strategy*, which works towards a *vision* (TSLG, 2012).

**Guidance:** The third decision often captured in a strategy is *what* specific activities can be delivered to assist with reaching the envisioned future position. However, some strategies do not go into this level of detail, and it is not compulsory. Although the Strategist role is responsible for this activity, it is likely that domain experts will provide a considerable contribution. These stakeholders will be able to suggest feasible activities that are likely to be influential. The Plan process will have determined which techniques and tools are the most suitable to the scale and complexity of the strategy. Any proposed activities must be linked to the overall statements of how the envisioned future position will be reached.

#### d. Maintain Traceability

The purpose of this activity is to ensure that the relationships between strategic decisions are captured and clearly illustrated. This concept, known as traceability, is usually associated with systems engineering or requirements management activities, and is not traditionally applied to designing strategy. However, the benefits are equally pertinent to strategy design. Traceability can demonstrate how a change to one part of the strategy might affect other areas. It enables the justification of decisions by identifying the source, and demonstrates the impact that changes to high-level decisions can have on the whole system. Traceability should be captured between:

- Related strategies (e.g. the EU White Paper and the Rail Technical Strategy)
- Source information and decisions (e.g. a Rail Technical Strategy *vision* and a key decision made in this strategy)
- Related decisions in this strategy (as shown in Figure IV)

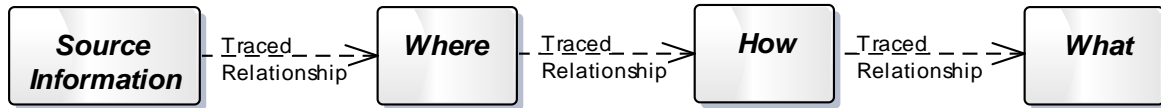


Figure IV – Traceability Links to be captured

**Stakeholder role responsible:** Integrator

**Information required:** Strategic decisions (*Where, How, What*)

**Information produced:** Traced relationships between strategic decisions and to their sources.

**Example:** Traceability is not traditionally applied in strategy design. However, many examples exist within the systems engineering and requirements management domains, where it is applied as standard good practice. The Academic Response to the Rail Technical Strategy provides a level of traceability by demonstrating how each research subject presented in the document aligns with the RTS (RRUKA, 2013).

**Guidance:** Traceability can be achieved in a number of ways, from introducing a coded system to creating maps of these relationships. Table X shows an example coding system for a strategy that is made up of *visions* (where), *strategies* (how) and *activities* (what). This simple approach would immediately highlight any activities that were not linked to a specific vision, potentially preventing unnecessary work before it has begun. Likewise, it could be valuable for identifying which activities would be affected by a change to a particular vision, thereby providing evidence which could be used to lobby decision makers.

Table I - Example traceability evidence

Source	Vision	Strategy	Activity
Output of workshop on 01/05/15	V1	S1.1	A1.1.1
			A1.1.2
			A1.1.3
		S1.2	A1.2.1
		S1.3	A1.3.1
			A1.3.2
		S1.4	A1.4.1
From Rail Technical Strategy	V2	S2.1	A2.1.1
			A2.1.2
			A2.1.3
		S2.2	A.2.2.1

This is just one suggested approach to illustrating the relationships between important information. Resources on requirements traceability can provide many solutions (Simpson,

2009) (Kerton, 2011). For large or complex strategy projects, it might be valuable to seek the expertise of a requirements traceability expert at this stage.

Q: Will the Strategy be decomposed for the design exercise?

Once strategic decisions have been made regarding the overall strategy, the strategy may be decomposed into individual areas, such as Rolling Stock or Infrastructure. This will have been determined during the Plan process. If the strategy will not be decomposed (which may be the case for a smaller scope of work), the following activity can be started.

**Stakeholder role responsible:** Design Manager

**Information required:** Strategy design plan

### 3. Decompose Strategy

If the strategy will be decomposed, this should be carried out in accordance with the work breakdown established during the Plan process. Subsequently, the first activities of the Capture process should be repeated for each individual area in the strategy, determining the *where*, *how* and *what* information for each area. Traceability should always be maintained between the decisions made for the overall strategy and those made for the individual areas. For example, there should be a clear link between the *visions* for the Rolling Stock section and those for the overall strategy. A description should be provided to explain how the individual areas of the strategy are related, which could be textual or diagrammatical.

**Stakeholder role responsible:** Design Manager

**Information required:** Strategy design plan

**Information produced:** Individual areas of the strategy, as decided during the Plan process.

**Example:** The Rail Technical Strategy is divided into six themes and three common foundations. Each section was produced by a specialist team then brought together with the assistance of a technical writer (TSLG, 2012).

**Guidance:** The strategy should be decomposed in accordance with the plan set out in the Plan process. The apportionment of work will depend on the scope of the strategy and the number of contributing stakeholders. Describe how the individual areas of the strategy are related in a diagram or a textual description.

### 4. Integrate Strategy

Once strategic decisions have been made for each of the individual areas, the strategy should be reassembled to form the integrated strategy. This is an important part of the process which will ensure that the final strategy is robust and sufficiently traceable.

**Stakeholder role responsible:** Integrator

**Information required:** Individual areas

**Information produced:** Integrated strategy – A consistent, integrated strategy where all the individual areas have been assembled.

**Example:** The Rail Technical Strategy Europe brings together eight ‘central elements’ that constitute the overall system addressed by the strategy. The strategy provides an overview of the system before presenting each of the different elements (UIC, 2014).

**Guidance:** Although the strategy may have been decomposed to manage the work, the final strategy should be consistent and traceable. An overview of how the individual areas of the strategy are related might be included. To maintain a consistent tone across the strategy, it might be beneficial to engage a technical writer at this stage. Traceability records should be combined to produce a complete view of how each area is aligned with the overall strategy. For more complex strategies, a systems engineer would provide valuable expertise to this activity.

## 5. Verification

The following activities are designed to check that the strategy fulfils key requirements before it is finally approved.

### a. Ensure Language Consistency

A language framework, including a common vocabulary and definitions, was established during the Plan process. During this activity, the integrated strategy should be checked against the framework to ensure that the vocabulary is consistent and that it has been used in the correct context. The strategy should be amended until the language used is consistent with the framework specified in the plan.

**Stakeholder role responsible:** Approver

**Information required:** Language framework, Integrated strategy

**Information produced:** Agreement that the strategy adheres to the language framework defined in the plan.

**Example:** The Rail Technical Strategy consistently applies the key vocabulary that was defined in the Introduction (*vision, objectives, strategy* and *enablers*) throughout the strategy (TSLG, 2012).

**Guidance:** This activity requires a thorough examination of the whole strategy against the language framework established in the plan. Firstly, it is recommended that any synonyms are removed (e.g. *goal* instead of *vision*). Secondly, the strategy should be checked to ensure that the vocabulary has been used in the correct context. It might be useful to include a linguist at this stage.

## b. Ensure Traceability Complete

The second check that should be performed is ensuring that the relationships between strategic decisions and their sources have been captured (traceability). The strategy should be amended until all decisions in the strategy can be linked to its source.

**Stakeholder role responsible:** Approver

**Information required:** Integrated strategy, Traced relationships, Strategic decisions

**Information produced:** Agreement that all strategic decisions are fully traceable to each other and to their source.

**Example:** Traceability is not traditionally applied to strategy design. However, many examples of traceability checks exist within the systems engineering and requirements management domains, where it is applied as standard good practice.

**Guidance:** Traceability can be tested by choosing a low level decision in one part of the strategy (e.g. a *Rolling Stock activity*) and attempting to link it to a high level decision for the overall strategy (e.g. a *vision* for rail) or another source. If all the low level decisions can be linked to its source, this aspect of traceability is complete. The highest level decisions should also be checked upwards to ensure that there is a link to its source (e.g. another strategy or the outcome of a workshop).

Q: Is the initial purpose fulfilled?

Finally, the integrated strategy should be checked against the initial purpose determined in the Plan process. If specific measures were agreed with the Client, these can be checked at this point. The strategy should meet the requirements set out by the Client, otherwise the Capture process should be repeated until the initial purpose has been fulfilled.

**Stakeholder role responsible:** Authoriser

**Information required:** Integrated strategy, Strategy purpose

**Information produced:** The completed strategy (authorised by the Client).

**Example:** The DfT Command Paper *Reforming Our Railways* was endorsed by the Secretary of State for Transport, who was the customer of the work (Department for Transport, 2012c).

**Guidance:** The final activity in this process could potentially be contentious. If the strategy purpose was not clearly defined, or the strategy does not fulfil the agreed requirements, the Capture process may need to be repeated from the beginning. If the strategy is significantly different to the required outcome, the Plan process may also need to be repeated. However, if the purpose of the strategy was clearly defined and agreed during the Plan process, it is more likely that the Client will be satisfied. Alternatively, if the Client is not satisfied but the strategy clearly meets the purpose that was agreed (and captured), the exercise should be considered a success.



## Finish

Once the Client is satisfied, the end of the process has been reached and the strategy is completed. For the strategy to be subsequently disseminated, for example in a published document, the Communicate process should be followed to ensure that all mandatory information is included.

**Stakeholder role responsible:** Authoriser

**Information required:** Verified strategy

**Information produced:** Completed strategy

## Communicate Process

### Overview

The final Strategy Design process is Communicate. The purpose of this process is to effectively communicate the strategic decisions and supporting information established during the Plan and Capture processes to a specific audience. A strategy document is one example of how strategic decisions might be communicated. Other methods include oral presentations, online resources and internal reports. The Communicate process should be followed when any form of strategy dissemination is required. At the end of the process, the user will have produced a disseminated strategy. The process can be repeated for each method of dissemination required. Figure V shows the order of the activities which make up the process and the role responsible for each. The process begins at the black circle and is completed when the user reaches the 'polo' shaped circle at the end of the sequence. The Communicate process can be started after or in parallel with the Capture process, once the Plan process has been completed. The information that is required in the Communicate process will have been produced during the previous two processes. The activities and team roles will be explained in further detail below, including examples and references to additional resources.

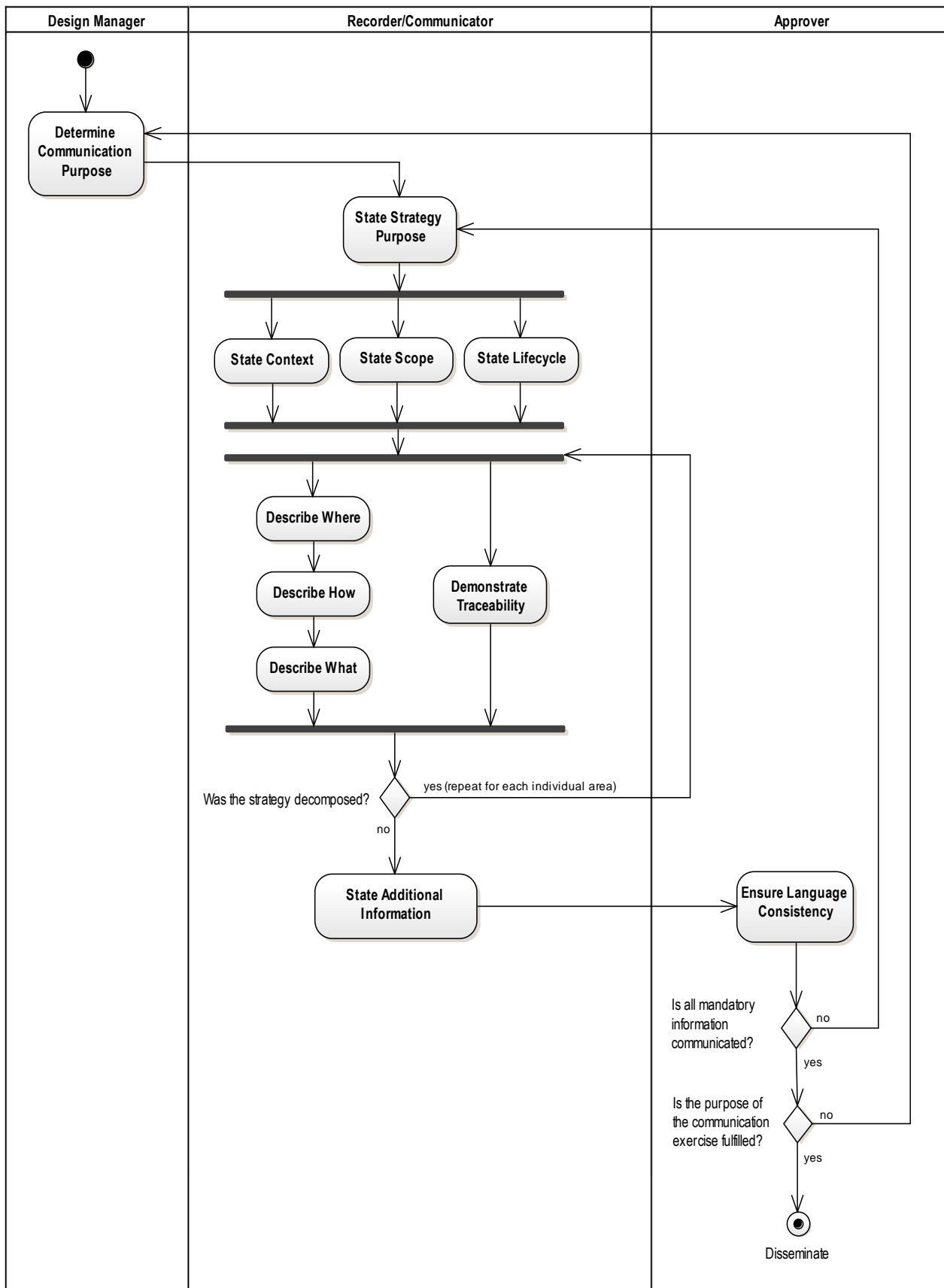


Figure V - Overview of the Communicate process

## Stakeholder Roles

The three main roles responsible for communicating the strategy are:

- The **Design Manager** – agrees the work with the Client, assembles the design team and sets working practices.
- The **Recorder/Communicator** – captures the information produced throughout the process and communicates it to a specific audience.
- The **Approver** – approves the strategy at different stages of its design, including the final approval.

Although three different *roles* are responsible for capturing the strategy, this does not necessarily equate to four individual *people*. For example, the Design Manager and the Approver roles could be performed by the same person. It should also be remembered that the name of the role does not relate to a particular job title, but rather describes the role held during this process. For example, the Recorder/Communicator role does not need to hold the title of *Recorder* or *Communicator* in the organisation.

## Communicate Activities

### 1. Start

The Communicate process should be started once all the activities in the Plan process have been completed, and may be carried out in parallel with the Capture process. The information that constitutes the disseminated strategy will have been produced during these processes.

**Stakeholder role responsible:** Design Manager

**Guidance:** The Design Manager should check that all the activities in the Plan and Capture processes have been sufficiently completed before instructing the team to begin communicating the strategy. One way to facilitate this activity is to produce a check list for the Plan and Capture activities and only proceed once each one is marked as complete.

### 2. Determine Communicate Purpose

A strategy may be communicated in various different ways according to the intended audience. For example, the version of a strategy which is presented to the CEO of an organisation is likely to be different to the version which is made available to the public. Before communicating the strategy, it is important to determine the purpose of the communication exercise. The process can be repeated each time a new perspective of the strategy is required. This activity is the responsibility of the Design Manager, who should refer to the strategy design plan for details of the planned types of dissemination.

**Stakeholder role responsible:** Design Manager

**Information required:** Strategy design plan

**Information produced:** Communication purpose – The perspective and intended audience for this particular dissemination of the strategy.

**Example:** The White Paper for Transport (European Commission, 2011a) communicates information produced during the exercise to determine a strategy for the Single European Transport Area.

**Guidance:** Refer to the strategy design plan to determine the purpose of this specific communication exercise. Consider:

- The intended audience
- The particular scenario
- Constraints, such as word limit
- The expected form of dissemination (published document, website etc.)

There are many techniques which can help with determining purpose, such as holding workshops, studying related documents, producing questionnaires, and requirements modelling. Further resources include: (Kupersmith, et al., 2015), (Holt, et al., 2011), (Alexander & Stevens, 2002).

### 3. State Strategy Purpose

During the Plan process, the purpose and expected outcome of the strategy design exercise were agreed. This information should be included in all communication of the strategy so that the reader has a clear understanding of what the strategy addresses.

**Stakeholder role responsible:** Recorder/Communicator

**Information required:** Strategy purpose, Communication purpose, Language framework

**Information produced:** Strategy Purpose – A clear and concise statement describing the purpose of the strategy.

**Example:** *Challenge 2050 is the European rail sector's shared perception of where the rail system could be by 2050* (CER, et al., 2013).

**Guidance:** Refer to the strategy purpose agreed during the Plan process. The statement can be tailored to the particular communication scenario, providing that the meaning is not affected. For example, the original statement of purpose might have specified that a strategy document would be delivered. This information may not be required in the strategy document which is delivered. If the purpose is communicated as a textual statement, guidelines for writing clearly should be followed (Alexander & Stevens, 2002) (European Commission, 2015). Vocabulary should be consistent with the language framework established during the Plan process. Alternatively, a diagram might be used to communicate the purpose or to

support the textual description (Cummings & Angwin, 2011) (Holt, et al., 2011). An example dissemination approach is shown in the accompanying Case Study document.

#### 4. *State Strategy Perspective*

The following three activities are related to the wider perspective of the strategy. This information was produced during the Plan process and can be communicated in any order.

**Stakeholder role responsible:** Recorder/Communicator

**Information required:** Strategy design plan, Communication purpose, Language framework

##### a. State Context

During the Plan process, the strategy was described within its wider context. This information should be included in all communication of the strategy so that the reader understands how the strategy relates to the wider environment.

**Information produced:** Context Description – A description of the strategy context, which could be a diagram or written as text.

**Example:** The Rail Technical Strategy includes a description of the *Policy and Planning Context* (TSLG, 2012, p. 11).

**Guidance:** Refer to the context description developed during the Plan process. The description can be tailored to the particular communication scenario, providing that the meaning is not affected. For example, a context diagram might be considered clearer than the textual description in the strategy design plan. Many resources are available to provide further guidance on developing a context diagram, such as (Burge, 2011) and (Olsen, 2014). An example dissemination approach is shown in the accompanying Case Study document.

##### b. State Scope

During the Plan process, the scope of the strategy was established. This information should be included in all communication of the strategy so that the reader understands the boundaries of the strategy and only necessary work is carried out.

**Information produced:** Scope description – A description of the scope of the strategy, which could be a diagram or written as text.

**Example:** *This document is our Strategic Business Plan for England & Wales for the five year period from April 2014 to March 2019* (Network Rail, 2013).

**Guidance:** Refer to the scope description developed during the Plan process. The description can be tailored to the particular communication scenario, providing that the meaning is not

affected. A diagram might again be considered to replace or support a textual description. An example dissemination approach is shown in the accompanying Case Study document.

#### c. State Lifecycle

During the Plan process, the lifecycle of the strategy was described, from the initial instruction to its eventual withdrawal or replacement. This information should be included in all communication to aid the planning of the strategy delivery.

**Information produced:** Lifecycle description - A description of the lifecycle of the strategy, from its initiation to its expected withdrawal.

**Example:** The 2014 Passenger Rolling Stock Strategy describes its historical context in relation to an earlier version and against a timeline of key activities (RSSSG, 2014).

**Guidance:** Refer to the lifecycle description produced during the Plan process. The description can be tailored to the particular communication scenario, providing that the meaning is not affected. There are many ways to communicate a lifecycle, from models (INCOSE UK, 2009) to a textual description. A time plan for delivery could be shown as a Gantt chart (Gantt.com, 2012) or similar. An example dissemination approach is shown in the accompanying Case Study document.

#### 5. Describe Strategic Decisions and Traceability

The following four activities are related to the decisions captured in the strategy: *where* the organisation or system is envisioned to be in the future, *how* this will be pursued, and *what* activities will contribute. This information was produced during the Capture process and should be communicated in the logical order detailed below.

**Stakeholder role responsible:** Recorder/Communicator

**Information required:** Completed strategy, Communication purpose, Language framework

##### a. Describe Where

Information related to where the organisation or system is envisioned to be was determined during the Capture process. This is one of the fundamental parts of a strategy; therefore it must be included in its communication.

**Information produced:** *Where* information – Clear and concise statements describing where the organisation or system is envisioned to be by a defined point in the future (as set by the scope).

**Example:** One of the European Commission's core visions is to *grow Transport and support mobility while reaching the 60% emission reduction target by 2050* (European Commission, 2011a).

**Guidance:** Refer to the *where* information produced during the Capture process. The information can be presented in any way suitable to the communication purpose, providing that the meaning is not affected. Whichever name was chosen to represent this concept (e.g. *vision*) should be used consistently in accordance with the established language framework. Textual and visual communication techniques should be considered, such as (European Commission, 2015) (Cummings & Angwin, 2011) (Holt, et al., 2011). An example dissemination approach is shown in the accompanying Case Study document.

b. Describe How

Information related to how the envisioned future of the organisation or system will be achieved was determined during the Capture process. This is one of the fundamental parts of a strategy; therefore it must be included in its communication.

**Information produced:** *How* information – Clear and concise statements describing how the organisation or system will reach its envisioned future position.

**Example:** *The Government's strategy for CP5 is built around a rolling programme of electrification, making continued use of 'cascaded' modern electric rolling stock and exploiting synergies between schemes in order to efficiently meet forecast demand growth, support economic growth and better environmental outcomes, and secure cost efficiencies for both passenger and freight operators* (Department for Transport, 2012b).

**Guidance:** Refer to the *how* information produced during the Capture process. The information can be presented in any way suitable to the communication purpose, providing that the meaning is not affected. Whichever name was chosen to represent this concept (e.g. *strategy*) should be used consistently in accordance with the established language framework. The *how* information must be linked to the *where* information communicated in the previous activity. An example dissemination approach is shown in the accompanying Case Study document.

c. Describe What

Information related to what specific activities to initiate may have been determined during the Capture process. This is an optional part of a strategy; so it may not be present in the communication method.

**Information produced:** *What* information – Suggestions for the specific activities that can help to reach the envisioned future position of the organisation or system.

**Example:** The Rail Technical Strategy includes a number of specific *actions* to help deliver its innovation *strategy*, which works towards a *vision* (TSLG, 2012).

**Guidance:** Refer to the decisions made in the Capture process to determine whether any *what* information was proposed. Relevant information can be presented in any way suitable to the communication purpose, providing that the meaning is not affected. Whichever name was chosen to represent this concept (e.g. *initiatives*) should be used consistently in accordance with the established language framework. The *what* information must be linked to the *how* information communicated in the previous activity. An example dissemination approach is shown in the accompanying Case Study document.

#### d. Demonstrate Traceability

During the Capture process, relationships between *where*, *how* and *what* information will have been captured. It is important to communicate this information so that those who deliver the strategy understand how specific activities relate to the overall future position of the organisation or system.

**Information produced:** Traced relationships between strategic decisions and to their sources.

**Example:** Traceability is not traditionally applied in strategy design. However, many examples exist within the systems engineering and requirements management domains, where it is applied as standard good practice. The Academic Response to the Rail Technical Strategy provides a level of traceability by demonstrating how each research subject presented in the document aligns with the RTS (RRUKA, 2013).

**Guidance:** Refer to the traced relationships identified during the Capture process. Demonstrate traceability in a manner which is appropriate to the communication purpose. For example, the strict traceability used in engineering domains might be inappropriate for a public document. However, simple traceability can be communicated through the considered use of headings, tables, or diagrams. An example approach to recording traceability is shown in the accompanying Case Study document.

Q: Was the strategy decomposed?

If the strategy was decomposed, the *describe strategic decisions* activities should be repeated for each individual area. If the strategy was not decomposed, the subsequent activity can be started.

#### 6. State Additional Information

Some instances of strategy communication may require further information in addition to the minimum necessary information stated above. This information can assist with marketing the



strategy or presenting it in a particular manner. However, it is not critical for effectively communicating the foundations of a strategy.

**Stakeholder role responsible:** Recorder/Communicator

**Information required:** Strategy design plan, Communication purpose, Language framework

**Information produced:** Additional information

**Example:** The Network Rail Technical Strategy includes a Foreword by the Chairman (Network Rail, 2013).

**Guidance:** Refer to the purpose of the communication and the strategy design plan to determine whether any additional information is required for communicating the strategy. This might include:

- Endorsement
- Foreword
- Additional background information
- Images
- Executive Summary
- A plan for delivery

Communicate this information in a manner that is appropriate to the communication purpose; for example using textual descriptions (European Commission, 2015) or diagrams (Cummings & Angwin, 2011). Ensure consistency with the language framework specified during the Plan process.

#### 7. Ensure Language Consistency

During this activity, the communicated strategy should be checked against the language framework established during the Plan process to ensure that the vocabulary is consistent and that it has been used in the correct context. The strategy should be amended until the language used is consistent with the framework. A Glossary should subsequently be produced to include in the strategy.

**Stakeholder role responsible:** Approver

**Information required:** Language framework, Communicated strategy

**Information produced:** Agreement that the strategy adheres to the language framework defined in the plan.

**Example:** The Rail Technical Strategy consistently applies the key vocabulary defined in the Introduction (*vision, objectives, strategy and enablers*) throughout the strategy (TSLG, 2012).

**Guidance:** This activity requires a thorough examination of the communicated strategy against the language framework established in the plan. Synonyms should be removed (e.g. *goal* instead of *vision*) and vocabulary should be used in the correct context. Finally, a Glossary should be included in the communicated strategy. It might be useful to include a technical writer at this stage to ensure consistency.

Q: Is all mandatory information communicated?

Once the strategy has been communicated, it should be checked against the list of mandatory information specific in this guidance. The list, which related to relevant activities in the Communicate process, comprises:

- Glossary
- Strategy purpose
- Strategy context
- Strategy scope
- Strategy lifecycle
- *Where* information
- *How* information
- *What* information (if applicable)
- Whole strategy view
- Traced relationships

If any of the above information is absent from the communicated strategy, the process should be repeated until the strategy is complete.

Q: Is the purpose of the communication exercise fulfilled?

Finally, the communicated strategy should be checked against the initial purpose of the communication exercise. If specific requirements or constraints were specified, such as page limit, these should be checked at this point. The process should be repeated until the communicated strategy fulfils the original purpose of the exercise.

Disseminate

At the end of the process, the communicated strategy can be disseminated in any way desired. Some strategies will be printed and distributed, whereas other may be disseminated internally via an online platform. Some will be accompanied by promotional initiatives, whereas the dissemination of other strategies might be more subtle. These details will have been determined during the Plan process and when determining the purpose of the specific communication exercise.

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APPENDIX B  
CASE STUDY

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# INTRODUCTION

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The following case study illustrates how the strategy design approach can be practicably implemented to design an example strategy. The purpose of this document is not to present a comprehensive strategy, but to demonstrate how each activity might be carried out for the given scenario. Likewise, it is not intended to dictate how each activity should be carried out, but rather to illustrate one possible application of the approach. The document presents an example output for each process; the Plan process produces a strategy design plan, the Capture process produces a completed strategy, and the Communicate process produces a strategy document. The section headings relate to the *information produced* by each process activity, as described in the Guidance document. It can be presumed that all decision points in the case study had a positive outcome.

The case study is based on a strategy design exercise for the Birmingham Centre for Railway Research and Education (BCRRE). The Centre is a prominent part of the University of Birmingham and is one of the largest railway research groups in Europe. In recent years, BCRRE has expanded at a rapid rate, both in terms of research and education activities, and in the number of personnel. The Centre has grown in an organic fashion, largely without limiting its research activities or future direction. However, as BCRRE continues to grow, its leaders recognise the increasing need to ensure the sustainability and future success of the group. In order to plan for the longer term, the Centre needs to develop a strategy.

# BCRRE STRATEGY DESIGN PLAN

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## Instruction

The Director of Birmingham Centre for Railway Research and Education has asked the Head of Development to lead the design of a five year strategy focused on ensuring the future sustainability of the Centre.

## Strategy Purpose

The purpose of this strategy is to establish the five year vision for BCRRE and to determine how the research and education activities of the Centre can best be aligned to achieve this. The outcome of the work will be a published document and a live online resource. The purpose of the strategy was decided during a workshop and has been agreed by the Director and the Head of Development for BCRRE.

## Design Team

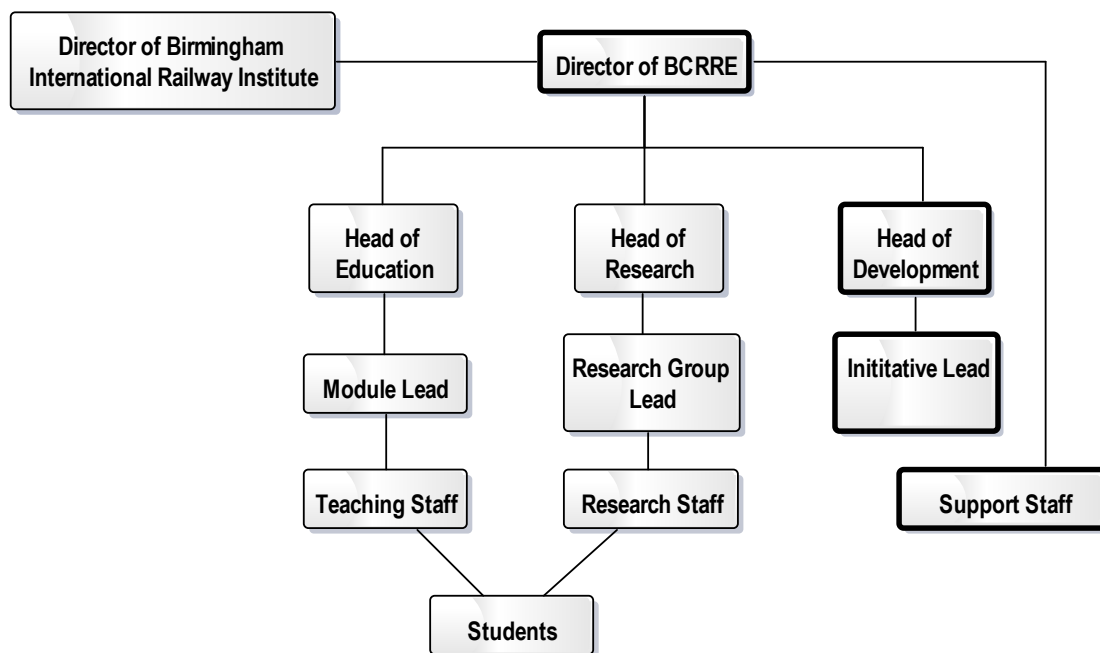


Figure A – BCRRE organisational structure

Figure A shows the general organisational structure for BCRRE. The six main roles responsible for developing the strategy will be filled by the following BCRRE roles:



**Customer** – Director of BCRRE

**Project Manager** – Head of Development

**Planner** – Strategy Lead

**Strategist** – Strategy Lead

**Integrator** – Administrator (support staff)

**Recorder/Communicator** – Administrator (support staff)

**Approver** – BCRRE Head of Development

These roles will be supported by a number of experts throughout BCRRE, including teaching, research and support staff.

## Strategy Perspective

### Context Description

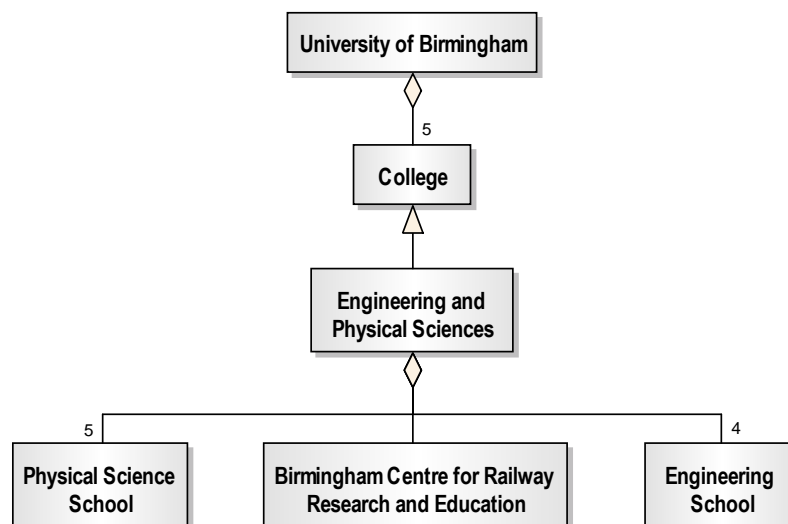


Figure B - BCRRE within the University of Birmingham structure

Figure B illustrates BCRRE's position within one of the five colleges which make up the University of Birmingham. As such, the Centre's strategy must be aligned with any existing strategies for the Engineering and Physical Sciences College and the University. The Centre works very closely with the UK rail industry and has a number of key international partners. Figure C shows the strategies that will be taken into account when developing BCRRE's strategy. It includes international strategies such as the EU transport strategy, and Government strategies including the Department for Transport strategy for reforming the

railways. Some of the strategies listed will be used as an information source for the BCRRE strategy, whereas others must be more strictly aligned.

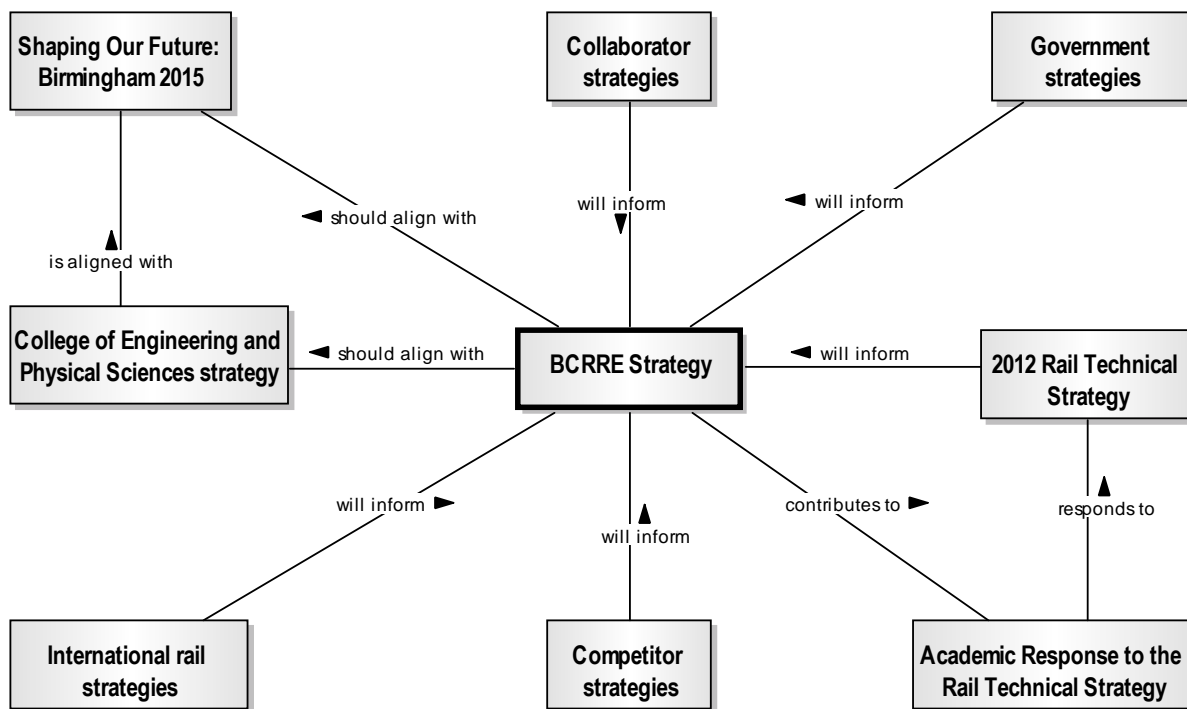


Figure C - Strategies related to BCRRE

### Scope Description

The scope of the BCRRE strategy includes all research, education and development activities at the Centre to the year 2020. It also includes a high level strategy for the Birmingham International Railway Academy (BIRA), which is the international arm of BCRRE. The intended audience of the strategy is the BCRRE leadership team, who will be responsible for its implementation. The published document will be suitable for dissemination to external contacts.

### Lifecycle Description

Figure D shows how the timescale of the BCRRE strategy compares to the timescale of other related strategies. The EU White Paper for Transport considers its vision up to 2050, whereas the Rail Technical strategy looks ahead to the next thirty years. As this is the first strategy for BCRRE, the initial timescale is relatively short, with a focus on putting in place over the next five years the foundations for sustainability. The live version of the strategy will be continuously updated throughout its five year validity. In 2020, it is expected that a new strategy will be developed to take the Centre up to 2030.

	2015	2020	2025	2030	2035	2040	2045	2050
BCRRE			2					
University of Birmingham								
EPS College								
Rail Technical Strategy								
Network Rail Control Period 5								
EU White Paper for Transport								

Figure D - BCRRE Strategy lifecycle

## Work Breakdown

The BCRRE strategy will be broken down into the following five themes, which will each be led by the role identified:

- Education (Head of Education)
- Research (Head of Research)
- Customers & Markets (Head of Development)
- Operations & Processes (Administrator)
- People & Organisation (Head of Development)

These themes were established during workshops with the leadership team and reflect the high level nature of this first BCRRE strategy. Future strategies are likely to provide further detail on specific research areas, such as Data and Energy. The strategy will be captured as a published document, with a live version made available online and regularly updated.

The following table shows the outline timeframe for completing the strategy. The work is expected to be completed by the end of September 2015, in order to inform the activities for the following academic year. The Centre’s overall vision is expected to be defined by the end of May, with the shared objectives and initiatives set by the end of June. Once these three central elements of the strategy have been determined, the work will be divided into its five core themes. Each theme lead will be responsible for developing a strategy for the theme which is in line with BCRRE’s overall position. These activities are expected to be completed by the end of August 2015, at which point the different parts of the strategy will be integrated and checked. Following any changes, the final strategy is expected to be published at the end of September.

Activity	Responsible	May 15	Jun 15	Jul 15	Aug 15	Sep 15
Set overall Vision	Strategy Lead	[Bar spanning May 15 to Jun 15]				
Set overall Objectives	Strategy Lead	[Bar spanning May 15 to Jun 15]				
Set overall Initiatives	Strategy Lead	[Bar spanning Jun 15 to Jul 15]				
Education	Head of Education	[Bar spanning Jul 15 to Aug 15]				
Research	Head of Research	[Bar spanning Jul 15 to Aug 15]				
Customers & Markets	Head of Development	[Bar spanning Jul 15 to Aug 15]				
Operations & Processes	Administrator	[Bar spanning Jul 15 to Aug 15]				
People & Organisation	Head of Development	[Bar spanning Jul 15 to Aug 15]				
Integrate strategy	Administrator	[Bar spanning Aug 15 to Sep 15]				
Authorise	Director of BCRRE	[Bar spanning Sep 15 to Oct 15]				

**Figure E - Timescale for completing the BCRRE Strategy**

## Information Sources

### Experts

In order to develop the BCRRE strategy, a number of domain experts will be called upon.

The expertise and experience of these people will help to best guide the future activities of the Centre. The following experts will be consulted:

- BCRRE module leads and teaching staff – play an integral part in delivering the Centre’s educational courses and their contribution will be essential for directing the future of the Education theme. Their input will also be sought for the Operations & Processes and People & Organisation parts of the strategy.
- Research leads and research staff – lead and deliver BCRRE’s research projects, which are a vital part of the Centre’s activities. The expertise and experience of these people are influential to the future direction of the Research theme. They will also be consulted on the Operations & Processes and People & Organisation parts of the strategy.
- Students – are actively involved in both the educational and research activities of the centre. Some students will both receive and deliver educational courses, so it is important that they are included in the Education part of the strategy development. The expertise and interests of the students is also a driving factor behind the research carried out by BCRRE, so they will be consulted on the Research part of the strategy. Students will also be included in considerations for the Operations & Processes and People & Organisation parts of the strategy.
- Funding bodies – are interested in the research conducted by BCRRE and are an important source of income for the Centre’s activities.
- Support staff – will be consulted in developing the Operations & Processes and People & Organisation parts of the strategy.

- External consultancy – will be used to advise BCRRE on the Customers & Markets part of the strategy. The consultancy will have expertise in assisting organisations with identifying their target customers and markets. The consultancy will collaborate with the BCRRE leadership team and provide recommendations on its future direction.

### **Other Sources**

In addition to input from the above experts, some key source information will also inform the BCRRE strategy. The context diagram presented earlier in this plan was used to identify important source information. The following sources will be consulted:

- The University of Birmingham and the College of Engineering and Physical Sciences strategies – will be used to ensure that any objectives set out by the University which impact BCRRE are fully taken into account when developing the vision and objectives of the Centre.
- Collaborator and Competitor strategies – will provide input to the work carried out by the external consultancy in proposing target customer and markets for BCRRE.
- Rail Technical Strategy – will also inform the direction of BCRRE’s Customers & Markets strategy, by identifying potential areas of growth for the industry (e.g. the Digital Railway).
- S.W.O.T. Analysis – will be carried out to identify the Strengths, Weaknesses, Opportunities and Threats to BCRRE, thus informing the overall strategy as well as the individual themes.
- Standards – will be taken into account to ensure that initiatives proposed in the strategy comply with relevant standards.
- BCRRE annual reviews – will inform the strategy by identifying any internal objectives which must be met.

### **Language Framework**

In order to ensure consistency and to reduce the risk of misunderstanding between members of the project team, a common language will be used throughout the development of the strategy and in the final published document. The language consists of a standard vocabulary which will be used to describe central concepts in the strategy, alongside set definitions. The common language is as follows:

**Mission** – why BCRRE (or the theme) exists.

**Vision** – where BCRRE (or the theme) is envisioned to be by a defined point in the future.

**Objective** – how BCRRE (or the theme) intends to reach its vision.

**Initiatives** – what will be done to support the objectives.

Once the strategy has been produced, it will be checked to ensure that the core vocabulary has been used consistently. A glossary will also be included in the published document to maximise clarity.

### **Decision Making Plan**

The experts and information sources identified will be used to produce the core parts of the strategy (vision, objectives and initiatives). Each of these concepts will be developed through the following activities:

#### **Document Analysis**

- The University and EPS College strategies will be studied to identify visions, objectives and planned initiatives that concern BCRRE and therefore must be taken into account.
- The Rail Technical Strategy will be examined alongside its Academic Response to identify potential industry requirements for research and education in the long term future.
- Customer strategies will be reviewed in order to identify potential areas of opportunity and value to the Centre.
- Competitor strategies will be studied to highlight areas where capability is not currently provided and therefore where BCRRE could position itself.
- Recent reports for BCRRE will be examined to capture internal objectives that have already been agreed.
- Standards will be considered to ensure compliance.

#### **S.W.O.T Analysis**

- An analysis of BCRRE's strengths, weaknesses, opportunities and threats will be undertaken by the external consultancy. Other activities, such as the document analysis and workshops are likely to inform the S.W.O.T. analysis. The outcome of this activity will inform the overall strategy and individual themes where valuable.

## Workshops

- A Student Workshop will be held with a selection of students from undergraduate and postgraduate railway-related courses. Their opinion will be sought on Education, Research, Operations & Processes and People & Organisation.
- A Research Workshop will be organised with research project leads, funders, and research staff in order to inform the Research part of the strategy.
- An Education Workshop will take place with module leads and teaching staff in order to inform the Education part of the strategy.
- An Administration Workshop will be held with support staff, research staff and education staff to discuss Operations & Processes and People & Organisation issues.

A clear link will be maintained between all decisions that are made and their source. Once each part of the strategy has been developed, they will be brought together into one complete piece of work. Checks will be made to ensure that background information and justification for each decision is clearly shown.

## End

The Project Manager (Head of Development) has confirmed that each activity in the strategy Plan process has been completed through the use of the simple checklist below. The project team may now proceed to capture the strategy.

**Table A- Process completion checklist for Plan**

<b>Plan Activity</b>	<b>Complete</b>
Agree Purpose	✓
Assemble Stakeholders	✓
Describe Context	✓
Describe Scope	✓
Describe Lifecycle	✓
Plan Work Breakdown	✓
Identify Experts	✓
Identify Other Sources	✓
Establish Language Framework	✓
Plan Decision Making Activities	✓

# BCRRE

## STRATEGY INFORMATION

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### Start

The Project Manager (Head of Development) has ensured that each activity in the Plan process has been carried out and agreed that the Capture process can be started.

### Strategic Decisions

#### Visions

A number of sources have been consulted to determine the 2020 vision for BCRRE. The first of these is the BCRRE mission statement, which was established in 2014 following a consultation exercise.

*Mission: The Birmingham Centre for Railway Research and Education provides fundamental scientific research, knowledge transfer and education to the railway community in the UK and around the world.*

The following visions have been identified in other strategies as having a potential impact on BCRRE’s future direction. These have been taken into account when developing this strategy. The key aspects of the visions have been emboldened.

**Table A - Visions in related strategies**

Source	Vision	Relevance	Ref
Shaping our Future: Birmingham 2015 (University strategy)	To become a leading global university, recognised by our peers as being both a dominant intellectual force and the destination of choice <b>nationally and internationally</b> .	The BCRRE strategy must align with this	S1
Rail Technical Strategy	A <b>whole-system approach</b> across the industry has fostered innovation and <b>attracted the best talent</b> . Entrepreneurs and innovators have the right conditions to develop new products and services and the export market is expanding.	Include ‘whole-system’ in vision Consider attracting talent in People & Ops section.	S2.1
Rail Technical Strategy	Network <b>capacity is optimised</b> to meet all requirements for passengers and freight. <b>Intelligent maintenance</b> has increased train and track availability and reduced perturbations and delays. <b>World-class asset management</b> is aligned across the industry to improve performance, lower costs and reduce business risk.	Continue work on capacity optimisation and intelligent maintenance. Consider how to improve asset management expertise across industry.	S2.2



Rail Technical Strategy	<b>Flexible, real-time intelligent traffic management and in-cab signaling</b> has reduced headways and decreased traction energy consumption. Control centres know the precise location, speed, braking and load of every train on the network to optimise operational performance and keep passengers informed.	Progress and disseminate simulation work.	S2.3
Rail Technical Strategy	Carbon emissions have decreased through the <b>widespread electrification</b> of the network and <b>sustainable, energy-efficient solutions for the remaining non-electrified routes</b> . Energy recovery systems in rolling stock and alternative fuels allow trains to lower costs and run on and off the electrified network. Sustainable Development Principles are embedded in the design, construction and operation of infrastructure and rolling stock assets and the <b>railway is resilient to climate change</b> .	Continue pantograph work and research into alternative energies and climate change resilience.	S2.4
Rail Technical Strategy	The industry is increasingly cost-effective as more efficiencies are introduced. Unplanned maintenance and damage to track and train are minimised through <b>enhanced industry-wide condition monitoring</b> . Generic designs for buildings and rolling stock interfaces are used instead of costly bespoke solutions to simplify expansion, upgrades and replacements. Operational and customer communications are supported by <b>equipment that can be updated with plug-and-play fitments</b> .	Continue condition monitoring work. Build expertise in operational and customer comms.	S2.5
Rail Technical Strategy	Rail services are integrated with other transport modes so that passengers have seamless door-to-door journeys. <b>Station information systems and personalised messaging</b> offer passengers all the relevant information to travel easily and reliably to their destinations. Passenger friendly stations eliminate the need for queues or physical barriers. <b>Revenue collection and security are based on electronic systems</b> . High-speed 1 links to the continent and is augmented nationally by High-Speed 2 which provides high-capacity, high-speed links between London, Birmingham, Leeds and Manchester and direct links to Heathrow Airport.	Build expertise in station information systems and app development (revenue collection etc.)	S2.6
A Better Railway for a Better Britain (Network Rail)	To be a <b>trusted</b> leader in the rail industry.	Maintain BCRRE's trusted reputation (as a strategic partner of NR)	S3

Taking into account the above strategies and following a workshop with the leadership team, the following has been established as BCRRE's overall vision:

*Vision (Vo): To be the largest and most influential University based Railways Centre in Europe, delivering academic excellence internationally by educating the railway leaders of tomorrow and conducting transformational research for the railway leaders of today.*

In addition to the overall vision for the Centre, the following specific visions have been established.

**Table B - Specific visions for BCRRE**

Source	Theme	Vision	Ref
S1, S3, S.W.O.T.	Recognition	To be recognised and trusted by our peers both nationally and internationally.	V1
S2.1, S.W.O.T.	Whole-System	To be an established leader in whole-system thinking for rail.	V2
S2.1, S.W.O.T.	Talent	To be a significant industry partner in attracting the best talent to rail.	V3
S2.2, S2.3, S2.4, S2.5	Dissemination	To be the first point of enquiry for research in our core capability areas.	V4
S2.2, S.W.O.T.	Asset Management	To deliver world-class education in railway Asset Management.	V5
S2.5, S2.6, S.W.O.T.	Emerging Technology	To have recognised capability in developing emerging technologies for the railway.	V6

## Objectives

The objectives listed in Table C set out how BCRRE will achieve the six main visions established above. Each objective has been linked to its related vision, as detailed in the table below.

**Table C - Objectives for BCRRE**

Vision Ref	Objective	Ref
V1	Accept work that we know we can deliver effectively.	O1.1
V1	Maintain a balance of both national and international research.	O1.2
V2	Improve our education offer in Systems Engineering.	O2.1
V2	Improve our research portfolio in systems thinking.	O2.2
V2	Become a recognised systems engineering institution.	O2.3
V3	Engage with industry to anticipate future required skills.	O3.1
V3	Develop the talent of the future.	O3.2
V3	Facilitate the progression of students into industry.	O3.3
V4	Develop a consistent brand.	O4.1
V4	Provide our people with the tools required to consistently disseminate our research.	O4.2
V5	Share our Asset Management knowledge and expertise.	O5.1
V6	Identify future areas of growth for emerging technologies in rail.	O6.1
V6	Increase collaboration with non-traditional/non-rail experts in emerging technologies.	O6.2

## Initiatives

In order to provide a direction for implementing BCRRE’s strategy, a high level plan has been drafted, proposing certain initiatives and identifying the role responsible. The plan was conceived following workshops with relevant groups of BCRRE people. Each initiative is linked to its related objective, which is in turn linked to an overall vision.

**Table D - Initiatives for BCRRE**

Objective Ref	Initiative	Ref	Responsible
O1.1 O1.2	Develop a research strategy to decide which areas of research are priorities (considering strategic value, interest, academic value, financial value).	I1.1	Head of Research
O1.1 O1.2	Develop a bid/no-bid process for deciding whether work is of value and should be accepted.	I1.2	Head of Development
O2.1	Increase the level of practical SE teaching (e.g. requirements management, modelling etc.)	I2.1	Head of Systems
O2.2	Actively pursue research with a strong systems thinking focus.	I2.2	Head of Systems
O2.2	Increase the output of systems related publications.	I2.3	Head of Systems
O2.3	Engage with INCOSE to ensure that BCRRE is recognised as a systems engineering institution.	I2.4	Head of Systems
O2.3	Develop our official offer in systems engineering and systems thinking.	I2.5	Head of Systems
O3.1	Organise talent requirement workshops with key customers.	I3.1	Head of People
O3.1 and O3.2	Develop joint MRes courses with industry partners based on their skills requirements.	I3.2	Head of People
O3.2	Actively recruit for a broader skillset of BCRRE staff and students.	I3.3	Head of People
O3.2 and O3.3	Develop a more formal internship programme.	I3.4	Head of People
O4.1	Complete update of brochures and research summaries.	I4.1	Head of Development
O4.1 and O4.2	Create standard templates for use at conferences and meetings.	I4.2	Head of Support
O4.2	Store BCRRE materials in a central location and provide clear guidance on usage.	I4.3	Head of Support
O4.2	Provide clear guidance on BCRRE’s activities and research direction.	I4.4	Head of Support
O5.1	Engage with industry to understand the asset management training needs.	I5.1	Head of Education

O5.1	Develop an MSc course in asset management.	15.2	Head of Education
O6.1	Align research with industry's vision for the Digital Railway.	16.1	Head of Research
O6.1 and O6.2	Identify opportunities for collaboration with tech companies.	16.2	Head of Research

## Traced Relationships

As illustrated above, each decision made in this strategy has been carefully aligned with its source and with related decisions. In addition to the tables above, the links between decisions have been mapped in a central model which will be made available in the online resource. The image below shows the section of the model related to vision 2 on whole-system thinking. The model enables BCRRE to justify key decisions which have been made and to perceive how a change to one part of the strategy might affect other areas. In addition, it shows how the planned initiatives for the Centre are aligned with external strategies, such as the Rail Technical Strategy. In the example below, it would be possible for BCRRE to estimate how changes to the industry strategy might impact the Centre, and vice versa.

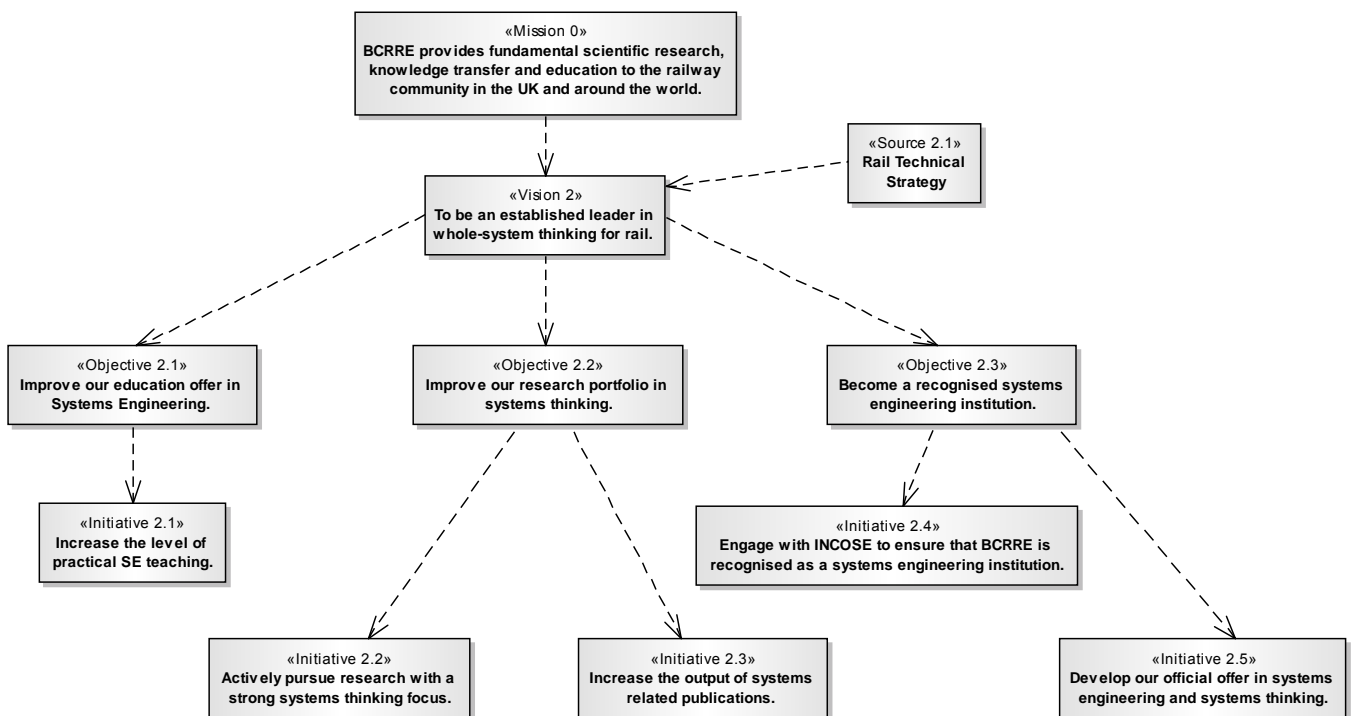


Figure A - A view of the BCRRE Strategy model

## Individual Areas

The BCRRE strategy is broken down into five, more specific areas: Education, Research, Customers & Markets, Operations & Processes, and People & Organisation. Visions, objectives and initiatives have been established for each area in line with those already set out for the whole of BCRRE.

BCRRE's overall visions, objectives and initiatives have been considered in developing the detailed sections of the strategy. For example, the table below shows which of the decisions related to vision 2 were considered to be relevant to each particular area, from Education (E) to People & Organisation (P&O).

**Table E - Relevance of overall visions, objectives and initiatives on specific areas of the Strategy**

Ref	Decision	E	R	C&M	O&P	P&O
V2	To be an established leader in whole-system thinking for rail.	X	X	X		X
O2.1	Improve our education offer in Systems Engineering.	X		X	X	X
O2.2	Improve our research portfolio in systems thinking.		X	X		
O2.3	Become a recognised systems engineering institution.	X	X	X		
I2.1	Increase the level of practical SE teaching (e.g. requirements management, modelling etc.)	X				X
I2.2	Actively pursue research with a strong systems thinking focus.		X	X		
I2.3	Increase the output of systems related publications.		X			
I2.4	Engage with INCOSE to ensure that BCRRE is recognised as a systems engineering institution.	X	X		X	X
I2.5	Develop our official offer in systems engineering and systems thinking.	X	X		X	

The table shows that even where a particular vision appears to be unrelated to a theme (e.g. Operations & Processes), there might be specific initiatives linked to that vision which are relevant (e.g. I2.4 and I2.5). The visions, objectives and initiatives which were identified as relevant were taken into account when developing each section of the strategy. Other sources which informed these decisions were related documents, workshops and the S.W.O.T. analysis.

## Integrated Strategy

Once the five detailed sections of the strategy were completed, they were assembled to produce the whole strategy. The diagram below provides an overview of the composition of the strategy. It shows that the BCRRE strategy is made up of overall visions, objectives and initiatives for the Centre, and five sections. The strategy is informed by sources (the S.W.O.T. analysis, output from the workshops, and documents), and the detailed sections are informed by the overall decisions for the Centre.

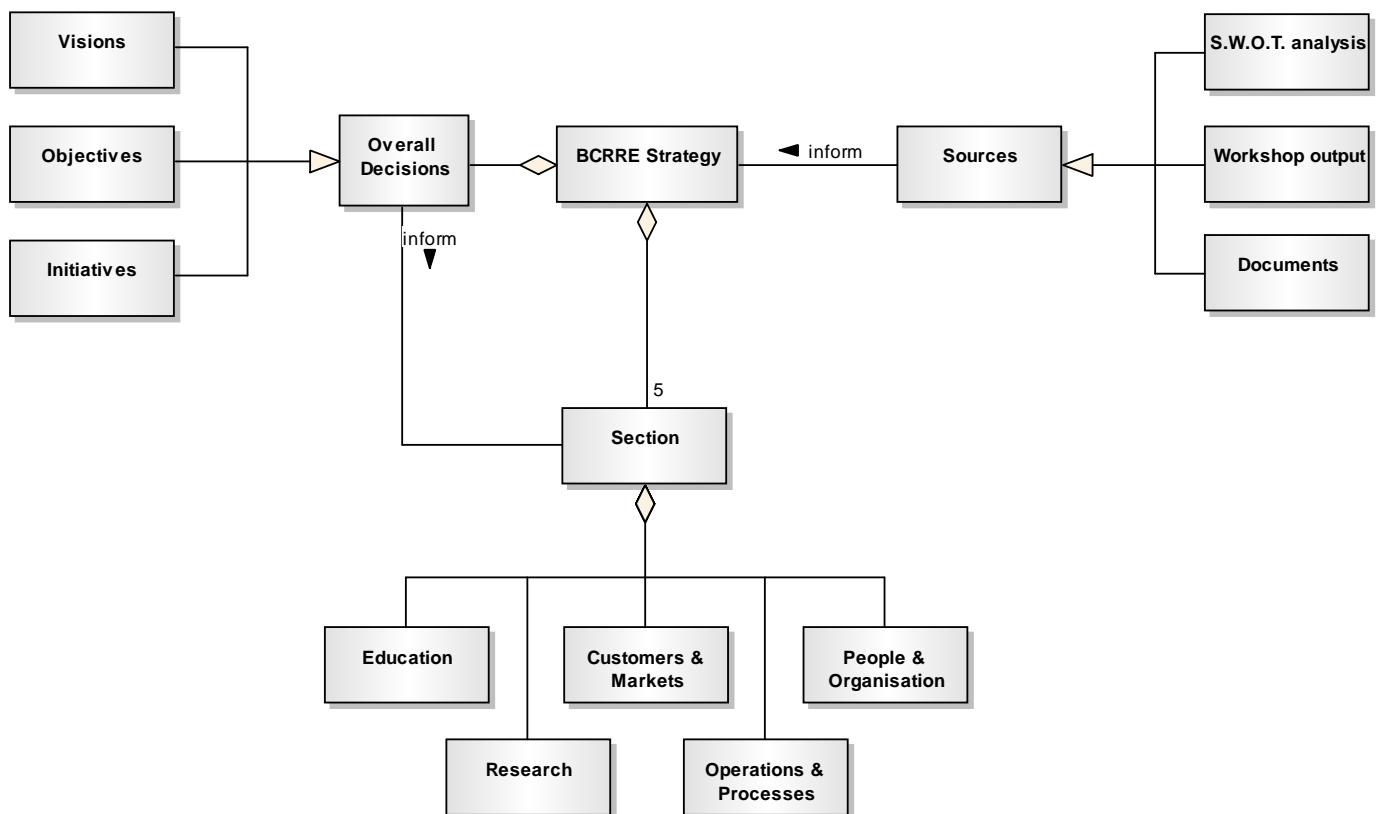


Figure B - Overview of the BCRRE Strategy and the specific areas

## Verification

### Language Consistency

The vocabulary and definitions set out in the Strategy Development Plan have been adhered to throughout the design of the BCRRE strategy. A technical writer has ensured that the language used in each section of the strategy is consistent. A glossary will be included alongside any dissemination of the strategy.

## Complete Traceability

Once the separate parts of the strategy had been integrated, the links between decisions in each section were incorporated into the overall traceability model. A check was then made to ensure that each initiative set out in the strategy could be justified. The diagram below shows the example of the Operations & Processes section, where there was no link from Initiative OPI2 and its source. All missing links have been amended to ensure that the strategy is fully traceable.

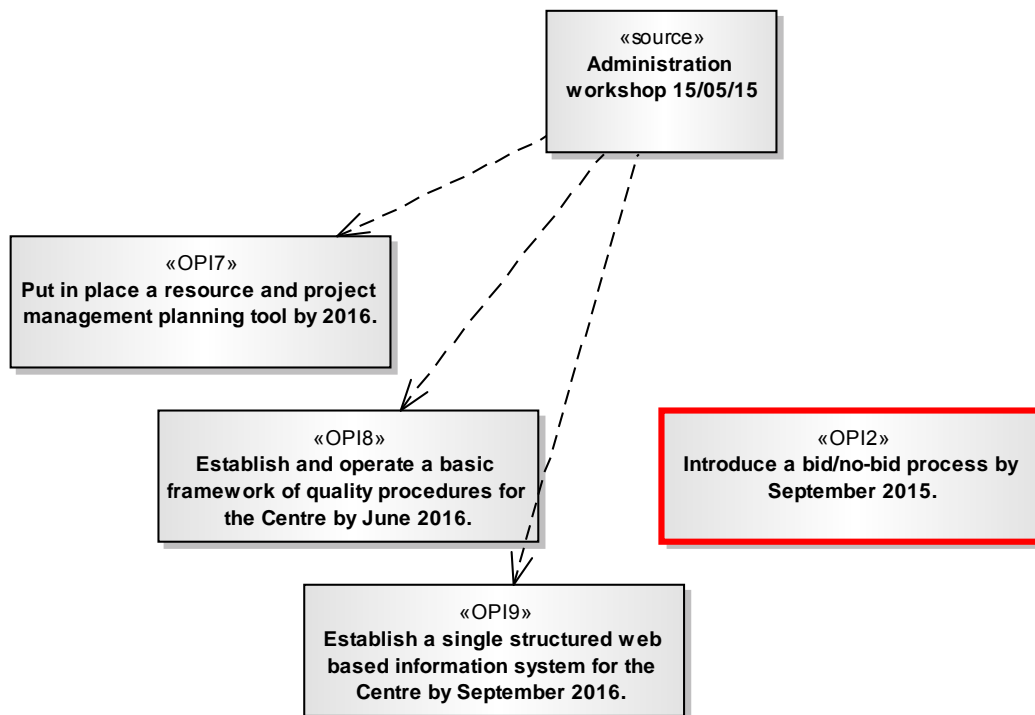


Figure C - Example traceability check for the BCRRE Strategy

### Q: Is the Initial Purpose fulfilled?

The initial purpose of this project was to set the five year vision for BCRRE and to determine how the research and education activities of the Centre can best be aligned to achieve this. The Director of BCRRE is satisfied that this purpose has been met and has authorised the completed strategy.

# BCRRE STRATEGY DOCUMENT

---

### Document Purpose

The purpose of this document is to communicate the new five year strategy for the Birmingham Centre for Railway Research and Education (BCRRE). It is intended for our staff, students and partners.

### Strategy Purpose

The BCRRE strategy establishes a five year vision for the Centre and determines how the research and education activities of the Centre can best be aligned to achieve this. The strategy will be disseminated through this document and as a live online resource.

### Strategy Perspective

### Context Description

The figure below illustrates BCRRE’s position within one of the five colleges which make up the University of Birmingham. The Centre’s strategy is aligned with existing strategies for the Engineering and Physical Sciences College and the University.

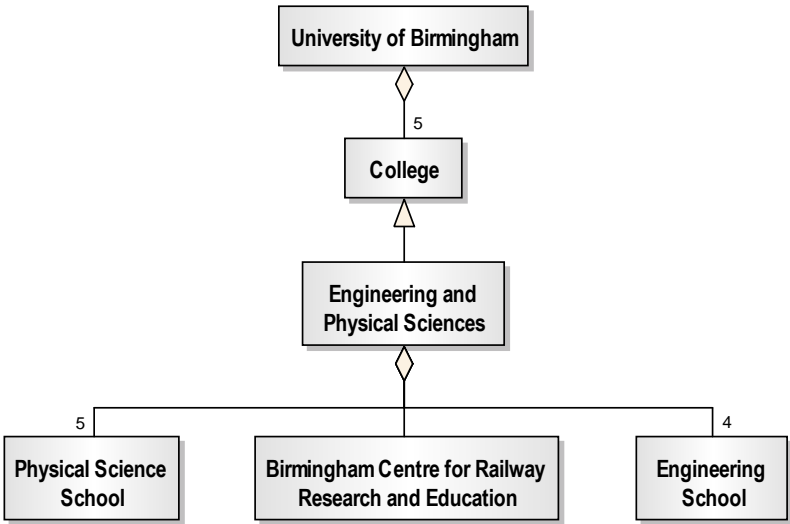


Figure A - BCRRE within the University of Birmingham structure

The Centre works very closely with the UK rail industry and has a number of key international partners. The figure below shows the strategies which were taken into account when



developing BCRRE’s strategy. It includes international strategies such as the EU transport strategy, and Government strategies including the Department for Transport strategy for reforming the railways.

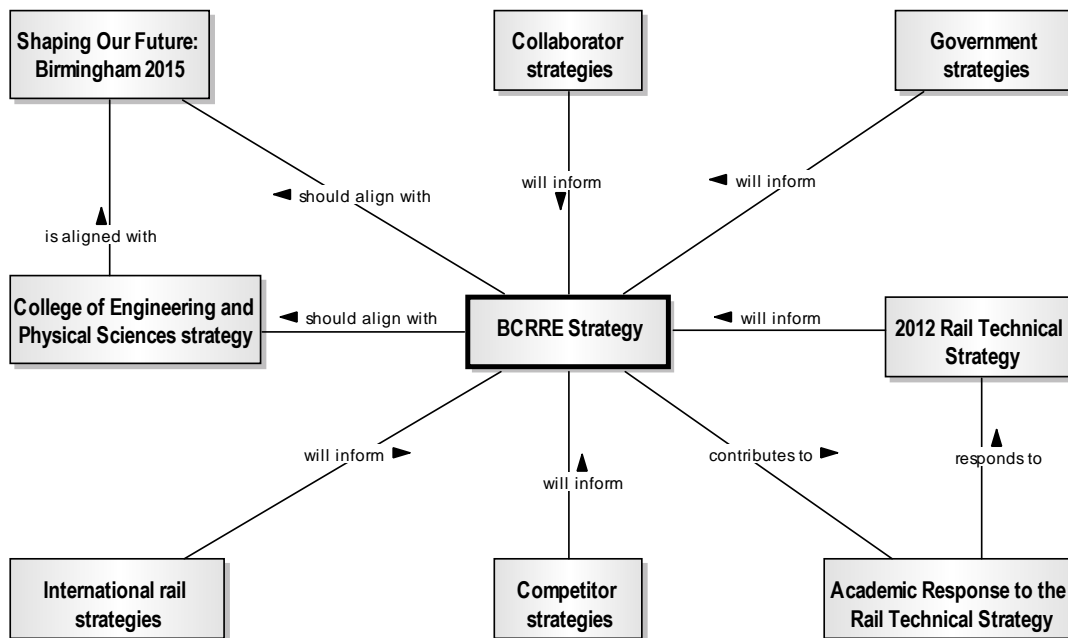


Figure B - Strategies related to BCRRE

### Scope Description

The scope of the BCRRE strategy includes all research, education and development activities at the Centre to the year 2020. It also includes a high level strategy for the Birmingham International Railway Academy (BIRA), which is the international arm of BCRRE.

### Lifecycle Description

The table overleaf shows how the timescale of the BCRRE strategy compares to the timescale of other related strategies. The EU White Paper for Transport considers its vision up to 2050, whereas the Rail Technical strategy looks ahead to the next thirty years. The timescale for this initial BCRRE strategy is relatively short, with a focus on putting in place over the next five years the foundations for sustainability. The live version of the strategy will be continuously updated throughout its five year validity. In 2020, it is expected that a new strategy will be developed to take the Centre up to 2030.

	2015	2020	2025	2030	2035	2040	2045	2050
BCRRE			2					
University of Birmingham								
EPS College								
Rail Technical Strategy								
Network Rail Control Period 5								
EU White Paper for Transport								

Figure C - Timescale for completing the BCRRE Strategy

## Strategic Decisions

### Glossary

**Mission** – why BCRRE (or the theme) exists.

**Vision** – where BCRRE (or the theme) is envisioned to be by a defined point in the future.

**Objective** – how BCRRE (or the theme) intends to reach its vision.

**Initiatives** – what will be done to support the objectives.

### Visions

The BCRRE mission statement was established in 2014 following a consultation exercise. It states:

*The Birmingham Centre for Railway Research and Education provides fundamental scientific research, knowledge transfer and education to the railway community in the UK and around the world.*

Taking into account related strategies, including the 2012 Rail Technical Strategy and *Shaping our Future: Birmingham 2015*, the following overall vision has been established for BCRRE:

*To be the largest and most influential University based Railways Centre in Europe, delivering academic excellence internationally by educating the railway leaders of tomorrow and conducting transformational research for the railway leaders of today.*

In addition to the overall vision for the Centre, the following specific visions have been established.

**Table A - Visions for BCRRE**

<b>Vision</b>	<b>Ref</b>
To be recognised and trusted by our peers both nationally and internationally.	V1
To be an established leader in whole-system thinking for rail.	V2
To be a significant industry partner in attracting the best talent to rail.	V3
To be the first point of enquiry for research in our core capability areas.	V4
To deliver world-class education in railway Asset Management.	V5
To have recognised capability in developing emerging technologies for the railway.	V6

## **Objectives**

The following objectives set out how BCRRE will achieve the six main visions established above. Each objective has been linked to its related vision, as detailed in the table below.

**Table B - Objectives for BCRRE**

<b>Vision Ref</b>	<b>Objective</b>	<b>Ref</b>
V1	Accept work that we know we can deliver effectively.	O1.1
V1	Maintain a balance of both national and international research.	O1.2
V2	Improve our education offer in Systems Engineering.	O2.1
V2	Improve our research portfolio in systems thinking.	O2.2
V2	Become a recognised systems engineering institution.	O2.3
V3	Engage with industry to anticipate future required skills.	O3.1
V3	Develop the talent of the future.	O3.2
V3	Facilitate the progression of students into industry.	O3.3
V4	Develop a consistent brand.	O4.1
V4	Provide our people with the tools required to consistently disseminate our research.	O4.2
V5	Share our Asset Management knowledge and expertise.	O5.1
V6	Identify future areas of growth for emerging technologies in rail.	O6.1
V6	Increase collaboration with non-traditional/non-rail experts in emerging technologies.	O6.2

## Initiatives

In order to provide a direction for implementing BCRRE’s strategy, a high level plan has been drafted, proposing certain initiatives and identifying the role responsible. The plan was conceived following workshops with relevant groups of BCRRE people. Each initiative is linked to its related objective, which is in turn linked to an overall vision.

**Table C - Initiatives for BCRRE**

Objective Ref	Initiative	Ref	Responsible
O1.1 O1.2	Develop a research strategy to decide which areas of research are priorities (considering strategic value, interest, academic value, financial value).	I1.1	Head of Research
O1.1 O1.2	Develop a bid/no-bid process for deciding whether work is of value and should be accepted.	I1.2	Head of Development
O2.1	Increase the level of practical SE teaching (e.g. requirements management, modelling etc.)	I2.1	Head of Systems
O2.2	Actively pursue research with a strong systems thinking focus.	I2.2	Head of Systems
O2.2	Increase the output of systems related publications.	I2.3	Head of Systems
O2.3	Engage with INCOSE to ensure that BCRRE is recognised as a systems engineering institution.	I2.4	Head of Systems
O2.3	Develop our official offer in systems engineering and systems thinking.	I2.5	Head of Systems
O3.1	Organise talent requirement workshops with key customers.	I3.1	Head of People
O3.1 and O3.2	Develop joint MRes courses with industry partners based on their skills requirements.	I3.2	Head of People
O3.2	Actively recruit for a broader skillset of BCRRE staff and students.	I3.3	Head of People
O3.2 and O3.3	Develop a more formal internship programme.	I3.4	Head of People
O4.1	Complete update of brochures and research summaries.	I4.1	Head of Development
O4.1 and O4.2	Create standard templates for use at conferences and meetings.	I4.2	Head of Support
O4.2	Store BCRRE materials in a central location and provide clear guidance on usage.	I4.3	Head of Support

O4.2	Provide clear guidance on BCRRE's activities and research direction.	14.4	Head of Support
O5.1	Engage with industry to understand the asset management training needs.	15.1	Head of Education
O5.1	Develop an MSc course in asset management.	15.2	Head of Education
O6.1	Align research with industry's vision for the Digital Railway.	16.1	Head of Research
O6.1 and O6.2	Identify opportunities for collaboration with tech companies.	16.2	Head of Research

### Themes

The strategy is divided into the following five themes:

- Education
- Research
- Customers & Markets
- Operations & Processes
- People & Organisation

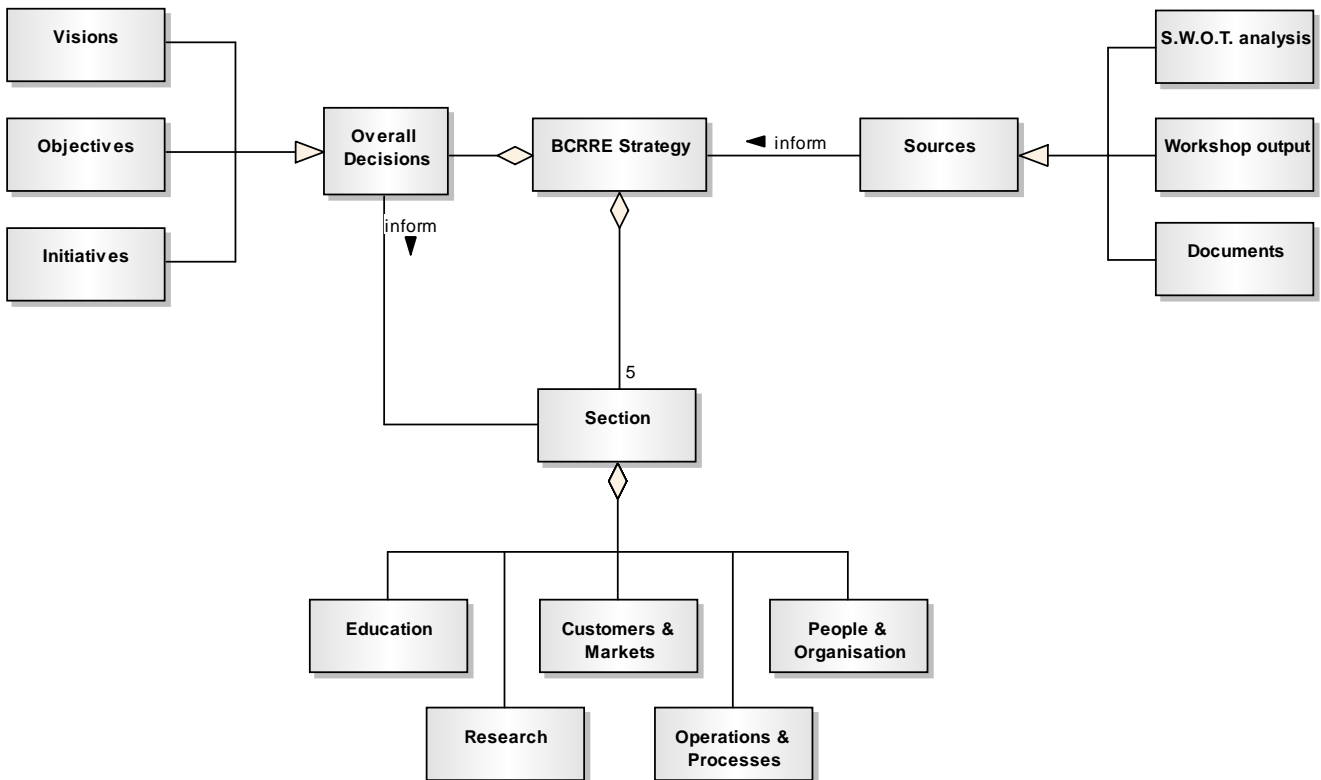


Figure D - Overview of the BCRRE Strategy and the specific areas

The diagram below provides an overview of the composition of the strategy. It shows that the BCRRE strategy is made up of overall visions, objectives and initiatives for the Centre, and five themes. The strategy is informed by sources (the S.W.O.T. analysis, output from the workshops, and documents), and the detailed sections are informed by the overall decisions for the Centre. The visions and objectives of each theme are in line with BCRRE’s overall position.

### Traced Relationships

As illustrated above, each decision made in this strategy has been carefully aligned with its source and with related decisions. In addition to the tables above, the links between decisions have been mapped in a central model which will be made available in the online resource. The image below shows a view of the model related to vision 2 on whole-system thinking. The model enables BCRRE to justify key decisions which have been made and to perceive how a change to one part of the strategy might affect other areas.

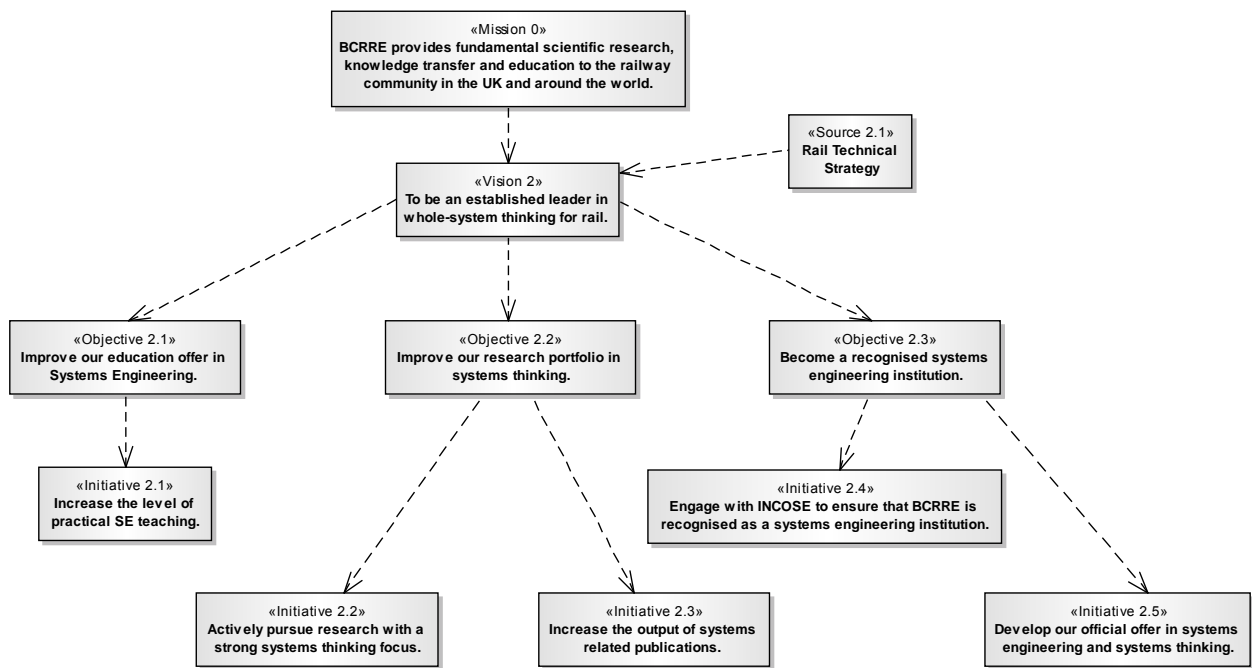


Figure E - A view of the BCRRE Strategy model

APPENDIX C  
USER WORKSHOP  
QUESTIONS AND FREE ANSWERS

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## LMR34 Minor Assignment

### Team Exercise

The following questions are related to the LMR34 team exercise. Think about how your team performed the following tasks:

1. Identify requirements in the 4 policy documents
2. Compile the requirements in the Excel spreadsheet
3. Develop the requirements

#### Do you agree with the following statements?

	Agree	Mostly agree	Mostly disagree	Disagree
We found task 1 easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We performed task 1 well	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We found task 2 easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We performed task 2 well	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We found task 3 easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We performed task 3 well	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

#### Briefly explain how your team organised Task 1 - identifying requirements in the 4 policy documents.

The following questions are related to the policy documents which you used for the team exercise. Only consider the short extracts provided for the exercise.

#### Policy 1 - the 2011 EU White Paper for Transport (from Team Exercise material)

Please choose whether you mostly agree or disagree with the following statements.

	Mostly Agree	Mostly Disagree
The document is easy to understand.	<input type="radio"/>	<input type="radio"/>
There are no requirements in the document.	<input type="radio"/>	<input type="radio"/>
The meaning of each sentence is clear.	<input type="radio"/>	<input type="radio"/>
There is at least one requirement in the document.	<input type="radio"/>	<input type="radio"/>
It is easy to find the information I am looking for.	<input type="radio"/>	<input type="radio"/>
The document is poorly written.	<input type="radio"/>	<input type="radio"/>
The paragraphs are the correct length.	<input type="radio"/>	<input type="radio"/>
I have the skills needed to read this document.	<input type="radio"/>	<input type="radio"/>
The paragraphs are too long.	<input type="radio"/>	<input type="radio"/>
The document is difficult to understand.	<input type="radio"/>	<input type="radio"/>
The document is well written.	<input type="radio"/>	<input type="radio"/>
The key information in the document is clear.	<input type="radio"/>	<input type="radio"/>
The document is suitable for an engineer.	<input type="radio"/>	<input type="radio"/>

(This question was repeated for each of the four documents)



Select the document which most corresponds to the statements below.

WP - EU White Paper for Transport  
HLOS - High Level Output Specification  
TSI - Official Journal of the European Union  
RTS - Rail Technical Strategy

	WP	HLOS	TSI	RTS
Contains the most requirements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Easiest to read	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Most complicated	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Best structure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Clearest	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Most important	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Most technical	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Most ambiguous	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Least suitable to engineers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Most understandable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Most well-known	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Least important	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Most suitable to engineers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Have you submitted the following work?

	Yes	No (if no, you MUST submit this work as part of your minor assignment)
1. The Context Diagram created by your group in the LMR34 team exercise	<input type="radio"/>	<input type="radio"/>
2. The Information Model created by your group in the LMR34 team exercise.	<input type="radio"/>	<input type="radio"/>
3. The Excel requirements spreadsheet completed by your group in the LMR34 team exercise.	<input type="radio"/>	<input type="radio"/>

# FREE ANSWERS TO USER EVALUATION SURVEY

Respondent Number	'Briefly explain how your team organised Task 1 - identifying requirements in the 4 policy documents.'	'Please provide additional comments related to the Team Exercise or this survey.'
1	We distributed the source documents amongst the team members to initial identify and highlight some outline requirements. These were then swapped and checked by another group member to A/D what had qualified as a requirement. Some source documents were dense with potential requirements whilst others were not very useful; these were quickly identified and we dedicated more time to review the more condensed source documents. We made sure that we conducted plenty of interviews to capture stakeholder requirements, particularly if the source documents were ambiguous, contradictory or unclear.	The team exercise was the best so far on the MSc, this was due to the style in which the Friday was conducted. The groups were smaller, therefore you weren't sitting through up to 8 other presentations, which meant people were more inclined to be interactive and engage with the Q&A. Also it meant people were less inclined to simply revise for the class test during other presentations, as the shorter session provided a longer revision session before the class test.
2	We all looked at the documents then assigned one document per person to derive requirements	The team exercise was important as it dealt with real documents and dealt with real issues. IT should be done again for future students
3	The requirements for the project where derived from various documents as depicted in the information model. The requirements are classified based on the discipline involved for easy transfer of responsibilities at a later stage The requirements are classified under four broad headings Stakeholder Operational Technical Environmental	
4	On day one of the assignment each team member was assigned one document from which to identify requirements. Each team member carefully read their allocated document and identified any requirements. These requirements were extracted from each document and compiled into one requirements document.	
5	We copied the 4 documents, then each brought our own ideas from each paper to discuss them.	
6	Our group had four team members, and there were four policy documents. We assigned each policy document to one person to review and pull out any requirements. After a first round, we switched our documents with another member to have a second set of eyes go through the documents again, and determine if there were any additional requirements within the document which may have been missed by the first reviewer. After identifying the requirements in the document, together as a group, we went through all of them together to determine if the requirement was actually a requirement, and if it was relevant	I think the team exercise was well organised but could use some clarification if it continues next year. In particular, while the idea of pulling out requirements from the documents and putting them into an excel sheet, there was some ambiguity in terms of what specifically to look for (it was cleared up too late in the week), and what specifically to put in some columns and their differences, i.e. the difference between "notes" and "justification." Additionally, as a native English speaker who regularly works with requirements, it was not terribly difficult to grasp the concept of writing requirements. However, being in a group with non-English speakers and those who

	to our project (Glasgow HS2 station). If a requirement was not relevant to our project, we still put it into the Excel spreadsheet as an identified requirement, but then noted in the spreadsheet that it did not apply to this project.	have never dealt with these types of requirements before, it was evident that some significant time should have been spent on what requirements are, how to interpret them, and how to write them. Specifically, determining the difference between technical and non-technical requirements (particularly difficult in the EU white paper), and how to write them with emphasis on language (the use of "shall" vs. "should" was a bit difficult for me to explain to non-English speakers, as they did not understand directive language). Regarding this survey, the only comment I would have is the last comparison between the four different policy documents-- the one item was "the most well-known," which was not entirely clear to me and could be interpreted as ambiguous if you are intending on using this as a research piece. Not being from the EU, I have not heard of any of these policies before this team exercise, so me answering which one was the most well-known was not entirely an accurate question. It may be good, in the future, to include a "N/A" or "Other" option (where someone could type in an answer) in case of these ambiguities.
7	Our team have 4 students, So we divided policy documents into 4 parts. And everyone seperately compile and develop requirements. Then we collected it together.	If give more extra time for team exercise , it is much better for me to understand every requirement.
8	We underline the useful sentences of the 4 policy documents, according to our team exercise requirement.	It is better to provide more understandable documents for students to read.
9	each group member in charge one document. first, identify requirements individually. then, present requirement in group	This team exercise is helpful for understand what is requirement. But there are no specific perspective in the identify process, only in presentation.
10	The group decided to review the four documents collectively on the Monday night and highlight potential requirements. With only one hard-copy version this was of moderate success. The team concentrated on wording, looking for directive text such as "must", "should" etc. Initially we took "should" to mean the requirement was merely desireable, however on seeking clarity we captured all requirements at this stage as mandatory. On the Tuesday night (having developed our context diagram and information model further), we took a number of documents each and extracted the requirements into the excel spreadsheet. We also made our first attempt at developing the requirements. At this point each member had the opportunity to review the requirements and challenge any wording or omission. Guidance in the class slides played an important role in this sense. There were two main weaknesses in this process: 1. Only one hardcopy. We should have copied the documents on the Monday evening. 2. Level of English. In some cases the requirement within the document may have been subtle and as such missed due to understanding. This is only a minor issue as we worked as a collective and picked up any missing requirements on a later review.	If possible in future runs of this assignment, maybe provide groups with two hard copies for ease of review. Other than this slight improvement, I found the assignment enjoyable and very worthwhile.
11	We split the four documents up amongst the four members of the team and reviewed one document each then one team member acted as the coordinator	The survey was difficult to answer in places as the answer given would be different in some cases depending on who and what you are i.e. the question r.e. the most

	to transfer all the identified requirements into the spreadsheet. We then reviewed the requirements as a group for applicability to our particular project and deleted any that we thought were not relevant leaving us with requirements that needed to be generated as 'developed requirements'.	important document would be different from an engineer perspective to a member of the transport select committee perspective.
12	The requirements were identified by myself in 3 of the 4 policy documents and 1 was done by the rest of the team. The whole team read each of the documents and reviewed these against the requirements captured. Any additional requirements were added or removed from the list following discussion.	Some of the questions in the survey were not clear as to what context they should have been viewed. For example in the eyes of an engineer or your own personal view.
13	To organised Task 1, it is done by these steps, such as: - we read the Project Brief of requirements for new High Speed 2 terminal station in Glasgow. - we identified requirements in the 4 policy documents that related with the Project Brief requirements. - we made diagram that shows the requirements from each document (5 documents) and relation between them in a system. - we also made groups and classified the requirements into, such as, users, infrastructure management, neighbours, regulations, etc., and draw them into a diagram.	We faced some difficulties especially in excel spreadsheet for filling developed requirements because the information in original requirements from documents, mostly, has no key information or specific limitation. For example, in European Commission - White Paper, it is mentioned that better rail/airport connections must be devised for long distance travel. The word of "better" has no boundary. To coped the problems, developed requirements were filled by referring to others regulations, making assumptions, and based on experiences of experts in our team exercise.
14	We divided the documents to each member of the group. And than each member identified in the brief and policy documents by studied the requirements which are required for related project. We also identified the requirement by looked at the best precise (railway, aircraft, etc) and made an interviewed with stakeholder such as : CEO of Crossrail ( C. Roberts), Local resident ( C.Watson), OFCOM (C.Roberts), Network Rail (C.Roberts), National Railway operators rep (F.Schmid) and Europian comission (C.Roberts). Finally, we combine our identification and discussed it to resulting the requirements.	The topic of this team exercise is quite hard. Therefore, in my opinion, we need more time to doing this exercise in order to make a deeper report.
15	We distributed one document to each person in the group for an initial review, highlighting clauses we each thought might constitute a requirement. We then reviewed them as a group and made brief notes and clause references in the Excel sheet.	My comments regarding the suitability of each document for engineers arise from the fact that I deal with TSIs on a frequent basis as part of my job. Even they I think are full of "Euro-speak" which from its nature as a committee Ament is never absolutely clear! The HLOS and the White Paper are also similarly affected by political language, and the derivation of specific project requirements is a challenge - although this is made slightly easier by allowing them to be classified as Preferential. In terms of the number of requirements, we had as many from the Project Brief (11, once distilled) as from each of the HLOS and the WP! With every respect to those whose first language is not English (I could not begin to imagine doing this exercise in any of the other languages I speak!), this exercise had much to do with 'reading between the lines' to get to the true meaning, which is particularly challenging when it's not your first language. This is not intended as a criticism; it's good experience for the real world of work.
16	we are split the document. one document for one person. after that we are discuss together our finding. how i find the requirement? i read the document carefully and try to find the keyword for this requirement.	Team Exercise was very exciting, great way to learn how to work in the real world. well organize and useful for student, must be continued. This survey is clear and easy to understand. Regards student

17	The task was divided amongst all the team members. Each member was given one policy document, and was asked to identify the requirements. Only those relevant to the project were meant to be chosen. If anyone was unsure of whether a clause is to be considered a requirement, it was discussed among other team members and then decided. The information model prepared by me helped in identifying the source of all requirements to be captured. My role was the preparation of an information model, and the identification of requirements from Policy 3 - "L 144" by the official journal of the European Union, mostly the detailed technical requirements.	The exercise gave a good insight into the process involved in the capture of requirements. The tasks were divided between the different members of the group, that is each member gathered some requirements. Given the difference in interpretation of the requirements, the compiled requirements specification did not appear as consistent as it was expected to be. A lot of time and effort were spent in making it appear consistent. Some of the requirements that were discussed with the stakeholders were very helpful in the understanding of the project requirements and ensuring its completeness. It could be noted that it is a bigger task to ensure the completeness of the requirements by filling in the gaps, than to only gather the requirements from the available documents.
18	Devide all documents to all of each and read deeply.	
19	We distribruted the documents around the group and individually highlighted what we thought were key phrases identifying requirements. Then we regrouped and together extracted our list of requirements.	
20	To identify requirements from the 4 policy documents and the brief as well, the 4 documents were reviewed by each member to the team to identify the requirements which are relevant to the project: Crossrail3. Then discussion and harmonisation were done by the whole team upon every member's findings to check their consistency and relevance to the project.	The requirements were identified not only in the 4 policy documents but also in the brief document. The exercise is effective to the identification and development of requirements for a given system.
21	We divided the four documents plus the client brief amongst the team and each identified requirements from our respective documents. We then combined the individual lists into one consolidated list. As a group we reviewed the list deleting invalid requirements. For the remainder we attempted to produce developed requirements that were simple and unambiguous. This stage was more difficult and only partially successful.	From my experience the client brief / contract technical specification would be the major source of functional project requirements. This would then reference a hierarchy of applicable standards which would provide a range of functional and system level requirements. Of the documents provided for the exercise only the TSI provides a level of unambiguous requirements, the other documents are strategic (ie vague) or in the case of the HLOS document really nothing more than a fairly random list of wishes.
22	We started to read each of the documents separately and tried to extract the relevant requirements to our work. We also have gone through the briefing and extracted the requirements from them carefully. In all of the phases we were discussing about the relevance of each of the requirements in the group.	The team exercise helped me a lot to understand the related concepts which were covered in the lectures. It was a good exercise in total.
23	we tried to identify the requirements with the statements or sentences that is using the word : "need, should, provide, must ensure and etc"	For team exercise : generally, it is good but better if after presentation for each group give some feedback directly so it can be better for next presentation. For survey : it is good but maybe surveyor must ask more about the understanding for each document as general or as detailed because most of the documents give general requirements not specific such as safety, integration, environment and etc.
24	We divided the 4 documents plus the client spec between the team and then worked through identifying requirements. These were then merged into a single combined list. We then jointly reviewed the list to develop the requirements.	
25	Each of us examined one of the documents and determined what relevant requirements it contained; we did not discuss this with each other.	

26	As the team of the project is the re-use of existing rail track, we tried to choose requirements relevant to the aim of the project. We identified environment policy as the re-use of the abandoned track is largely involved with environment issues. In addition, As for the successful completion of the project, the source of finance and the way of delivering finance were identified. The requirement about cost-effective way was also identified as our project is based on the re-use of existing track. In summary, it can be said that our team chose the relevant requirements to the aim of the project focusing on environment, cost-effective aspect, customer satisfaction, safety issue and finance source.	Generally, I liked the team exercise. It taught me about how to cooperate with others from different cultures. I believe this is very important in this world of globalization.
27	We have first of all read the brief of the the subject that talks about the requirements for re-opening of Great Central Main Line and we've gone through the source documents which are Network Rail Technical Strategy, Official Journal of EU, HLOS, and EU white paper to retrieve the requirements for the project. Then after we've shared ideas about the original and developed requirements to be written in the spreadsheet.	The team exercise was very interesting work for systems engineering and the survey is important for evaluation of railway projects.
28	The team read all policy documents, then discussed them within the context of the assignment as a group. We identified mandatory and preferential requirements and confirmed the scope of the assignment with lecture staff. We assigned each policy document to a team member and reviewed individually the requirements we had previously identified. Some requirements appeared in several documents; others initially appeared unrelated, but could be assigned to a theme (e.g. 'communication'). These were identified for subsequent review amongst the team.	Following stage 1 the requirements were transferred to the 'requirements template', whilst producing a 'developed requirement'; a 'rationale'; 'notes' and categorising each requirement as 'infrastructure', 'safety', 'operations', 'finance', 'systems wide' and other relevant categories. Similar requirements appeared in several documents, particularly 'reliability' (requirements R9, R10, R12, R13). They were recorded separately, but the similar requirements were cross-referenced. Some requirements initially appeared unrelated but further consideration revealed they had systemic links to others, particularly the 'communication'-based ones (requirements R27, R28, R30, R31, R32, R33, R34, R35, R36, R37, R39). These deal with the flow of train operating information: an efficient information management system between train operators, infrastructure managers, passengers and other stakeholders is essential to the smooth operation of rail networks. These relationships will help define the specifications and design. Personal knowledge of the proposed route helped the team identify project risks in addition to those in the briefing document, which could affect requirements, increase the project costs or introduce delays. For example: there are two preserved railways along the proposed route; the Woodhead tunnel houses high voltage National Grid power cables and the former Manchester Central station has been converted into a 10,400-person convention centre. The exercise was a good introduction to interpreting requirements and specifications. The survey is an innovative and welcome change to the minor assignment structure and one I would like to see repeated.
29	we took a time to discuss about what we have to do and how we have to do it, we started by doing the context diagram and the information model together as a group, and because the policy documents were too ambiguous and some not related and difficult to understand the documents were analyzed with the whole	The documents were too complex and difficult to get the requirements however, The HLOS document was somehow understandable. This survey at its last part could have four options (MA/D, A/D)

	group before each member was given one document to look for the requirements relating to our topic and write them in excel. The following day, we gathered all the requirements to develop them by making them measurable, one sentence and unambiguous so that they get a traceability with maximum understanding and they were classified into infrastructure, operation and environmental requirements. After getting all the requirements, the group started elaborating power point for presentation	
30	We identified the requirements comply with 4 policy documents. We have scanned all the 4 documents and found requirements related to the project. we shared the documents between each other to make it easy.	
31	our group split up the tasks as the policy document were a very large document and we had limited time: - Each member was allocated a document to analyse and come up with requirements. After, we compiled all our findings and together we prepared the document.	
32	We shared the notes and each have to highlight what the requirements are and how relate with the interfaces or with skateholders	Everybody in the team thought we should have more time to complete the team exercise.
33	We first of all read and understood the top level objective which was"RE-OPENING OF GREAT CENTRAL MAIN LINE".Then, the requirements were identified basing on that issue and must allow the top speed of 100mph, electrification of 25kv and be able to accommodate the Great Central Heritage.	The team exercise has been helpful since it made us to put theory into practice and this removed some difficulties we had before. This survey also is well organised in terms of having critical thinking and this will help me to judge each and everything in real and everyday life.
34	The documents were distributed between the different members to the team. Once the requirements were identified we discussed on their suitability and the best way to develop the requirements in direct sentences and avoiding ambiguity. After that we classified the requirements.	In my opinion this Team Exercise has been the one that I like the most so far. I clearly identified the importance and the difficulties in finding the requirements from the high-level documents up to the low-level requirements. The exercise gave the awareness of structuring the requirements. It is worth mentioning the format of the presentation. In this format, between three groups that had been working in the same problem, everyone understood the problems and the time for the questions and answers was really interesting.
35	We brainstormed and re read the notes again and again and asked for lecturer's input	It would have been more clear to students to have done a class exercise before the minor assignment, doing a context diagram and info model to get a feel for it. There was a lot of confusion when doing the minor assignment to get these parts correct.
36	We were 4 people, every member read, discuss and analyse what can be suitable for our project.	Information model and context diagram should be standardised (i.e using international template or format). Because during presentation, few groups were in dispute claiming which context diagram or info model is much appropriate.
37	We are group 5 doing HS2 Glasgow Central Station project, any relative requirements including mandatory, preference and stakeholder requirements have been investigated through 4 documents, e.g. Brief, Official Journal of The European Union, Customer Experience and European Commission White Paper, Lirong prepared the requirement from the Brief and I did the Customer Experience part, while Shane and Jean-Nepo investigated the requirements from	This is a new approach to minor assignment, the team exercise is closely associated with system engineering, it has helped me gain an appreciation of V model, decomposition and integration process, and the system engineering knowledge will be used in my job, probably next project, thinking more relative things (big pictures) rather than single one. I would not have in-depth understanding with regard to context model and information model if we did not do this team exercise, I fully understand relationships among the system, stakeholders and interfaces after the

	EU White Paper and Official Journal of The European Union. And then we put the information together.	team exercise. The team exercise project enhances system engineering knowledge, great design, fantastic module.
38	Our group has five groupers. We divided the 4 policy documents into 4 parts. Each person finished one part. We check the requirements and find the further information on internet. And we put all the requirements into the excel, and put the same requirements into the same blank.	The time is quite limited, so that we cannot get a perfect result. And the materials are quite difficult to overseas students. We have to make a supporting role. The type of the team exercise is good, but when handle it, there are many specific problems, for instant we have poor knowledge in the program.
39	sss	



APPENDIX D  
STAKEHOLDER INTERVIEWS

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03/04/2014

**Mark Gaynor, Department for Transport**

*Mark's role was to ensure that the Rail Technical Strategy fitted with overall policy by linking back to the Government. He also provide input into the latest HLOS, as well as Franchise Specifications.*

There are no overarching policy decisions on rail. The first Rail Technical Strategy was delivered by the DfT in 2007, the same year that the White Paper was released. The Technical Strategy Advisory Group was established and later became the Technical Strategy Leadership Group. The new RTS is industry-owned, and is therefore seen to have more weight. A steering group was established to develop the RTS. Mark's role was to link back to policy to ensure that the RTS fitted with overall policy.

Workshops were held with industry stakeholders and with key policy-makers to make sure that the document had government endorsement. One of the changes made as a result was to put reference to HS2 in the doc. The document was released with videos and a lot of PR - there was a conscious effort to make it different to previous documents. There was a lot of discussion during the process about how to structure and draft the document. The question was then how to turn the strategy into an actual delivery.

No other Member States had previously developed a RTS. It is important to get in first if you want to be influential. The UK RTS influenced Shift to Rail, which is an EU Joint Technology Initiative. The RTS was developed through a series of workshops. A lead was established for each chapter. There was engagement with the cross industry interface. The previous RTS was considered when drafting the new one. The RDG sat above the TSLG. The Energy chapter was drafted first, and became a sort of model/example for the other chapters. A technical author was brought in to add consistency across the document and ensure that the style was the same. Information with regard to franchise specifications was added.

The Rail Strategy team (in DfT) drafts documents such as the HLOS, Command paper etc. There is also a High Speed Command paper. DfT documents are often responses to something which has happened/been published. The McNulty report was triggered by internal DfT work showing that there were savings to be made.

03/04/2014

**Martin Brennan, RSSB**

Martin gave a description of the process for developing the Rail Technical Strategy.

The original Rail Technical Strategy stated that another document would be produced in 5 years by the industry. First, a group was established to develop the initial content for the RTS. This was done by talking to key people who knew the areas well.

An initial consultation document was developed and sent to key industry and academic people. It received 75 responses, some of them very detailed. Drop-in sessions were also held, where people brainstormed what they thought should go in to the RTS. A report was produced on the consultation process, saying that with a few amendments, the RTS had been approved by industry. All stakeholders were invited to be part of the process and most took part (Passenger Focus did not).

The development was a cyclic process. The content was taken back to the group leads and re-written to be accurate.

Challenge 2050 sits above the EU RTS. Documents can be used as a tool to lobby governments and influence policy. EU documents are led by the UIC. What is the vision for the UK? (There is no UK equivalent of Challenge 2050.) How can we deliver practical things which work towards the strategy? Franchise specifications must be written carefully with the RTS in mind. RSSB liaises with the DfT to ensure that the specifications are consistent with the overarching policy/strategy. The UK is well-placed to submit bids which they know are in line with the overall EU strategy. They can show that they meet criteria for tenders AND the overall EU strategy.

03/04/2014

**Peter Randall, Department for Transport**

*Peter is part of the Rail Executive at the DfT. He provided a historical overview of policy and strategy making for GB rail.*

Historically, the DfT did not have much to do with rail, which was mostly taken care of by British Rail. The structure which we have now has many interfaces, which is where there is risk and therefore a lot of cost. The most complex interface is the wheel-rail interface, and nobody owns this (NR own the rail, ROSCOs own the wheel.) The Ladbroke Grove accident initiated a big review of the rail industry structure. The Office of Passenger Rail Franchising (OPRAF) became the Strategic Rail Authority (SRA) in 2003. At this point, no-one was making high-level strategic decisions about the railway.

The SRA was capable of making decisions, but they were given too much financial freedom. SRA was demolished and became The Rail Group (DfT). The Rail Group was disbanded around a similar time to the McNulty Report, which concluded that there was a 'lack of strategic leadership' in the industry. The Rail Delivery Group was created in 2011 as an independent body whose purpose is to decide what the strategic direction of railways should be. The DfT's Rail Group became the Rail Executive, which may eventually become an independent Agency. The Rail Group has a project delivery team, which is unusual for Whitehall. Separation from government allows for quicker decisions.

Under the current structure, it takes too long to make decisions as they have to pass through all the civil servant ranks. An example of this is with electrification. It was originally felt by heads of strategy that electrification was never going to go anywhere and was a waste of money. However, the HST architecture was designed to include diesel and provision for electrification. Even though the overall strategy was not electrification, there were recognised benefits to including both technologies.

There was a shift in favour of electrification in 2009/2010. Due to fiscal stimulus, the Government ordered the DfT to buy 200 DMU vehicles. They rushed through a tender which was awarded in 6 months. However it fell down because there was no 'business plan'. The IEP project is still ongoing, with Hitachi delivering the trains. The Rail Group advises government and tries to bring everyone together, liaising with industry. The RDG has an independent advisory role. There is also a Chief Scientific Advisor on transport to the government.