Springer Tracts on Transportation and Traffic 2

Series Editor

Roger P. Roess
Polytechnic Institute of New York University
Metrotech Center 6
11201 New York
USA
E-mail: rroess@poly.edu

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Konstantinos Tzanakakis

The Railway Track and Its Long Term Behaviour

A Handbook for a Railway Track of High Quality

Springer

Author
Konstantinos Tzanakakis
Athens
Greece

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"It appears incontrovertible that understanding failure plays a key role in error-free design of all kinds, and that indeed all successful design is the proper and complete anticipation of what can go wrong."

Henry Petroski
Design Paradigms
Case Histories of Error and Judgment in Engineering

"Quality is never an accident; it is always the result of high intention, sincere effort, intelligent direction and skilful execution; it represents the wise choice of many alternatives"

William A. Foster

"Y***ou have to learn the rules of the game. And then you have to play better than anyone else***"

Albert Einstein

Foreword

Trains have to run on time, and a basic condition is that the quality of the track and other infrastructure objects is sufficient. Most of the physical systems and their components degrade/fail over time. This affects the performance of the system and can lead to system failures. Failure during operation can be costly, e.g. loss of service, property and even life.

The track engineer when he constructs, renews or maintains a track is of course aiming to deliver a track of high quality: but how does the quality affect the track costs and the service life of the track?

There is a lack of understanding of the relationship between track design, construction, usage and maintenance costs. Therefore it is of greatest importance to create common and better understanding of these relations.

Albert Einstein said "***you have to learn the rules of the game. And then you have to play better than anyone else***". The book aims to provide the necessary functional knowledge of the track behaviour, covering the function of the various track components, their interaction as elements of the track system, and the interaction of the systems track and railway vehicles. When we understand how the whole system functions (railway vehicles running on a track), taking into account its imperfections and showing how they influence the quality and performance of the system, then we learn the rules of the game, and we can "play better" in order to improve the efficiency of the Infrastructure Manager (IM), to improve the quality of the track for an optimum long term behaviour, using the available tools (i.e. RAMS, LCC) and choosing the best maintenance strategies (incl. any appropriate outsourcing strategies).

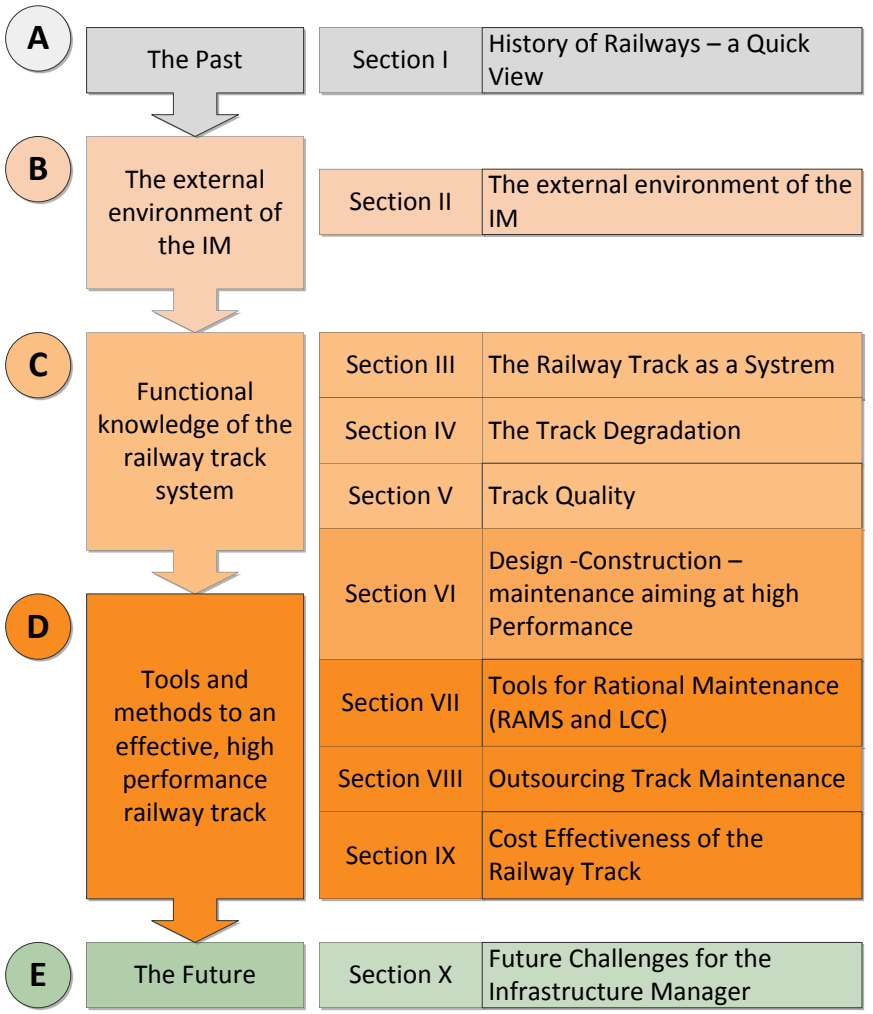
The aim of the IM is to design, construct and maintain an expensive asset, as it is the railway track, in a cost effective way, to assure its high performance during its service life. The only way to achieve this target is included in the word "**Quality**". If the Infrastructure Manager can achieve to get a new track of high quality, to maintain it with the optimum maintenance strategies, he will be able to manage a track with low costs and a high efficiency.

The IM has to act in an external environment, including the stakeholders, mainly the government and the society, which set increasing demands on the IM by providing at the same time less funding, as often foreseen in multiannual contracts between the State and the IM. The splitting of the traditional (integrated) railways in management of the infrastructure (responsibility of the IM) and operation (responsibility of the Railway Undertakings or Operators) introduced a new "player", the Railway Undertakings, who also set -through the contractual agreements with the IM- high demands on track efficiency.

Hence, the IM is under considerable pressure to act in a high demanding external environment, with a much lower budget than in the past. The tools for the

IM to manage a qualitative, efficient track with good long term behaviour are also being here presented here.

The book is structured in five parts (A, B, C, D, E) and 10 sections, as presented below. Confucius said "study the past if you would define the future". So, it starts with the Past (railway history), then the external environment for the IM is given describing the context in which the IM is acting, followed by the functional knowledge to understand how and why does the track system works as it works, tools and methods aiming at high performance, and finally it ends with the Future (the future challenges for the IM), consistent with the quote of Confucius. The following figure gives a respective overview.



Athens, December 2012 Konstantinos Tzanakakis

Overview

Part A: The Past	
Section I	**History of Railways – A Quick View** This section gives a quick view of railway history: The history of Railways dates back nearly 500 years, and includes systems with man or horse power and rails of wood or stone. Modern rail transport systems first appeared in England in the 1820s. These systems, which made use of the steam locomotive, were the first practical forms of mechanized land transport, and they remained the primary form of mechanized land transport for the next 100 years.
Part B: The external environment of the IM	
Section II	**The External Environment of the Infrastructure Manager (IM)** The Infrastructure Manager has to act in an increasingly challenging external environment. There are various stakeholders who have interests in the activities of the railway Infrastructure Manager. The available government budgets are decreasing, and at the same time there are increased needs for higher infrastructure capacity utilisation. An efficient way of managing the rail infrastructure is required.
Part C: Functional Knowledge of the Railway Track System	
Section III	**The Railway Track as a System** In this section the knowledge about the "how" and "why" of the track behaviour is provided, as a base knowledge for highlighting the importance of track quality.

Section IV	**The Track Degradation** In this section the track deterioration mechanisms are discussed, which lead to a degradation of the track, and also the factors influencing the durability of the track geometry. Recommendations and good practices for preventing the track degradation are also given.
Section V	**Track Quality** Quality should be the final goal for the Infrastructure Manager. In this Section we examine the importance of good quality and how quality affects the long term behaviour of the railway track.
Section VI	**Design -Construction – Maintenance Aiming at High Performance** A high performance railway track has to be designed and constructed properly. Consequently, when trains are running on the track (operational phase), the track has to be monitored and maintained. What are the possible maintenance strategies? Which strategy does best fits the needs and the culture of the various Infrastructure managers?
Part D: Tools and Methods for an Effective, High Performance Railway Track	
Section VII	**Tools for Rational Maintenance (RAMS and LCC)** In this section tools for the optimization of the track construction regarding technical and economic requirements are presented. LCC and RAMS technology are two acknowledged methods for assisting the optimization process regarding those requirements.
Section VIII	**Outsourcing Track Maintenance** Outsourcing of maintenance services is not a definite path to maintenance excellence. Through outsourcing it could be possible to cut cost and make the maintenance more effective. In this section, advantages and disadvantages of outsourcing, factors influencing decision making, types and characteristics of outsourcing contracts, and cases of applied outsourcing are topics discussed among others.

Section IX	**Cost Effectiveness of the Railway Track** The infrastructure as the main production factor in the railway system's value chain accounts for a significant part of the full system costs. Therefore it is very important for Infrastructure Managers to have a good control of infrastructure management in general and of costs in particular to improve competitiveness. Aspects that are discussed in this section include guiding principles for an effective railway track, methods to measure track performance, benchmarking as a practical tool for improving performance by learning from best practices and understanding the procedures by which they are achieved. Furthermore, a method for estimating costs related to maintenance and renewal of the track are also addressed.
Part E: The Future	
Section X	**Future Challenges for the IM** Today more trains are running on the track than in the past and the competition with other means of transportation is becoming greater. At the same time there is also a tendency towards decreased time and funds for maintenance. The characteristics of the future railway as a system will be discussed in this section.

Contents

Part C: Functional Knowledge of the Railway Track System

List of Figures

List of Tables