

T-M

TRANSPORTATION-MARKINGS:
AN INTEGRATIVE SYSTEMS
PERSPECTIVE:
COMMUNICATION,
INFORMATION, SEMIOTICS

Brian Clearman

Mount Angel Abbey

Second Edition

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Transportation-Markings:

An Integrative Systems

Perspective: Communication,

Information, Semiotics

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Transportation-Markings:

An Integrative Systems

Perspective: Communication

Informative, Semiotics

Part K

Volume IV, Final Studies

Second Edition

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Saint Benedict, Oregon

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PREFACE

The idea for this monograph goes back to 1998. It may have been a reaction to a growing collection of T-M studies that focussed on each of the four modes of transportation. Only limited work of an integrative nature had taken place up to that time. Integrative in this context means a work that centers on a study of T-M forms bringing together the various modes and resulting safety aids rather than dealing with separate entities. The idea remained in an inactive state (or at most in a germinating state) for some years. Though the idea did appear in monograph lists as a projected study with the curious title of “A Truly Integrative T-M.” While it may have been curious it also summed up the idea of the projected monograph.

This late monograph in the Series will focus exclusively on the integrative character of T-M forms. This is in contrast to most of the T-M studies since 1998 that have continued to focus on individual forms within a transportation mode. Even the composite study in the Database subdivided the information by modes. There are limited integrative materials in the Series. But often they have served as tools for examination of specific needs of T-M forms. This study, by contrast, presents T-M forms as an unified discipline. While it may tend toward an abstract construct it also maintains a concrete perspective to some degree.

Several alternate titles for the study have been tried out including “T-M as a Communication Study”/“T-M as an Information System”/“T-M as a Communication/Information System.” They all have drawbacks. Information System can

have a variety of meanings that include T-M yet it is unlikely that the term has been so employed. Communication can have multiple meanings. It also refers to direct human communication and telecommunication. Communication science, theory and technologies are specific dimensions of the communication field. T-M presence in that field is limited. Yet there are broader understandings of communication that can be applied to T-M. One such example is the original and current name of the T-M Series: Transportation-Markings: A Study in Communication Studies.

An early work that has influenced T-M is *On Human Communication* by Colin Cherry (2nd edition, 1966). He included not only communication topics that would gain general agreement but also other disciplines including language and semiotics. Perhaps the inclusion of “Human” in the title shifts work away from a nearly inclusive focus on theory of communication. However, the Series that included Cherry’s work (termed “Studies in Communication”) also included semiotic, language and linguistic titles. The title of that Series quite possibly was a partial source of the T-M title. In the 1980s Thomas Sebeok referred to semiotics “as the pivotal branch of the integrated science of communication” (in Blonsky 1985, 451-452; see also Jakobson 1970, 33). The word “integrated” may qualify the meaning of communication and the relationship of semiotics and communication.

The final element, semiotics/semiology, has a significant role in the study which was omitted from older alternative titles. A more recent examination of communication and semiotics will reveal points of commonality as well a notable

difference in perspective. And perhaps it displays less of a blurring of boundaries than are found in the older Studies in Communication term. The last term, System, remains a key term even when other changes were made in the several title concepts.

Further reflections on the theme, content and title for the study have led to a revised title:

*Transportation-Markings: An Integrative Systems
Perspective: Communication, Information, Semiotics.*

The title addresses the focus of the study and includes the major elements in a workable fashion. The revised approach to the study entails a second change: It can also be viewed as a kind of encompassing structure for all of the studies since its integrative nature provides a connecting link.

There have been two approaches to the T-M studies: the older version with a chronological and partly topical basis, and a newer version that is not yet in use. That newer version divides the studies into integrative, modal and data-base segments. This study can include the second version though only in an encapsulated form.

An outline of the second version has this appearance:

Integrative Studies

General Table of Contents**

7 editions, 2002-2010

Foundations

5 editions, 1981-2008*

Classification

3 editions, 1994-2010

History

1 edition, 2002

T-M: An Integrative Perspective:

Communication, Information, Semiotics**

2 editions, 2011, 2014

Modal Studies

Marine Aids to Navigation*

3 editions, 1981-2010

Traffic Control Devices

2 editions, 1984, 2004

Aeronautical Navigation Aids

1 edition, 1994

Railway Signals

1 edition, 1991

Adjunct Study: T-M in US (with 4 modes)*

2 editions, 1981, 1992

Database Studies

Marine

2 editions, 1997, 2007

Road

2 editions, 1998, 2008

Railway

2 editions, 2000, 2009

Aeronautical

2 editions, 2001, 2009

Composite

2 editions, 2006, 2012

*1st edition of three oldest studies were published in a unified edition by University Press of America, 1981.

**Two additional studies are projected: This second edition of T-M: An Integrative Systems Perspective: Communication, Information, Semiotics, and a final 8th edition of General Table of Contents.

Note

This edition of Integrative Systems is a component of what eventually may be termed “General Treatise” of Transportation-Markings. “GT” is a reconfiguration of the monographs consisting of the current editions (15) and is primarily digital (though a print form is feasible). An introductory unit prefaces the group of studies. The appearance of nearly 40 monographs in separate modes in search engines and other digital systems has diminished the idea of Transportation-Markings as an integrated concept. The reconstruction of T-M is not yet in an complete state.

CHAPTER ONE

INTEGRATIVE TRANSPORTATION-MARKINGS: COMMUNICATION/INFORMATION/SEMIOTICS, INDICATORS & CONTEXT

1A Basic Terminology

1A1 Communication/Informative Studies

a) Introduction

1) Chapter 1

This study of Transportation-Markings is divided into two chapters. Chapter 1, which is divided into three segments, looks at the tools needed to examine the process of analysis of messages and their meanings. Terminology is the primary content of the chapter. The first segment focusses on three overlapping processes: communication, information, and semiotics. Semiotics/Semiology occupies a central position in that process.

The second segment examines how messages are generated and transmitted. The centerpiece is the indicator which encompasses all of the means employed in T-M for making and transmitting messages. Messages and Meaning (or signification) is found largely in the first segment.

The third segment is that of context. Context is a component of the semiosis process within semiotics. Routeways/travelways are a major component of that context. The

context situates T-M forms within its environment.

Chapter 2 examines the actual operation of T-M processes: from indicators to messages and meanings. It is based on the foundations of messages formulated in the earliest T-M study (1970s). The primary coverage is divided into the four basic categories of message foundations with sections for indicators (the physical dimension), messages and meanings. However, two of the four (CMSM, UMM) represent very small categories. (see page 55 of *Foundations*, 2013 for information on systems of messages and acronyms).

2) Chapter 2

Terminology for this study takes several forms. Systems (1A2) serves as an overarching term in conjunction with T-M. Integrative (1A2) is included in the title of the study as a reference to the primary role of T-M in contrast to mode-specific orientation of most of the studies. Operational terms include Indicator (1A2) and Messages and Meanings. Indicator is introduced in this chapter and given greater attention in Chapter 2. Messages and meanings are integrated with the core terms (1A1) as well as Chapter 2.

The three core terms for this study have been grouped together under an acronym: C.I.S.: Communication, Information, and Semiotics. They can be separated yet the terms often overlap or become intertwined. There is a vast collection of definitions that can separate C.I.S., bring them together, or simply confuse the meaning and role they generate. For that reason they are brought together in the study in a way that can illustrate linkages between them as

well as indicate separate identities. The confusion that may surround them is also present. Yet T-M requires the three terms since a fuller explication of the generating and transmitting of messages, as well as the meaning of those messages, is gained by an integrated approach.

b) Communication & Information

Communication and Information can be defined in diverse ways. Admittedly, coherence and compatibility among the many entries may be difficult to discern. Communication descriptions often include the idea of transmission or transfer of information. A helpful definition of communication is to be found in Berelson & Steiner 1964: “Communication: the transmission of information, idea, emotion, skills, etc. by the use of symbols--words, pictures, figures, graphs, etc. it is the act or process of transmission that is usually called communication.” (in Schement & Ruben 1993, 25 [S&R]).

“Act or process” adds clarity to the core term of transmission and symbols clarifies the the nature of information in transmission. Danesi’s definitions of communication includes the “production and exchange of messages by mean of signals, facial expressions, talk, gesture, or writing” (Danesi 2000, 58). The semiotic perspective adds clarity to the transmission process of communication. A major focus in this study is the use of the term Indicator. They are technical devices that generate messages undergoing transmisson. In this study explanations of how devices works are included. The addition of concrete level of operations are necessary in this study in order to augment an easily constructed abstract explanation.

Information definitions are also diverse. In part because specialists in different fields within information produce explanations restricted to studies of limited scope. Ruben offers a helpful definition: “Information is a coherent collection of data, messages, or cues organized in a particular way that has meaning or use for a particular human system.” (Ruben 1988, 23 in S & R). Danesi gives further insights into information by defining it as “... any fact or datum that can be stored and retrieval by humans or machine.” He defines information in a context of information theory (and computer science) in a more technical perspective: “[the] ... precise measure of the information or context of a message” (Danesi 2000, 119).

Communication and information have been viewed as near synonyms (Schement 1993, 3). They can also be perceived as separate entities. An understanding of them as separate entities is more accurate than merely viewing them as interchangeable terms. But a more accurate view is to see CI as closely linked phenomena: transmissions require substances that can be quantified and a given quantity of signals requires a communication process (Schement 1993, 18-19). The process of communication/information also requires semiotics. Transmitting signals (of whatever form) requires an understanding of the meaning of messages. That function is better situated within semiotics than within information though some information constructs can include a dimension of meaning.

There are no simple explanations of terms and meanings in the CIS ensemble. Instead there are overlaps and more than

a little confusion. No matter the perspective it will be at some variance with adjoining viewpoints. The three-part assemblage probably can be maintained despite competing views. The distinctive yet linked roles can nonetheless be identified and explained coherently.

Jorge Schement observes that “Information and communication form dual aspects of a broader phenomenon” and “the special problem of information and communication reflects a duality embraced by some larger phenomenon for which there is no name at present.” (Schement 1993, 18). His remarks suggests an intriguing notion that the entire entity can be a larger and even encompassing totality. The physical generation and transmission of data (of whatever form) remains a separate entity from messages and meanings though integrated through links of common purpose and interaction.

It is apparent that there is a strong relationship(s) between communication and information. They represent individual characteristics yet there is an essential bond between them that brings about an integration of their operations.

However, it seems to be commonplace for a variety of communication and information sources to omit a semiotic perspective especially when messages and their meanings are under consideration. Messages and meanings can be explained by communication and information to some degree yet semiotics provide a varied perspective that enriches an understanding of messages and meanings. Nonetheless, extensive coverage of messages and meanings can bypass the explicit forms of the semiotic system.

Semiotics, by contrast, takes note of the place of communication and information and how it overlaps and/or differs from those alternate perspectives. Some degree of borrowing, or even cross-fertilization, may take place though semiotics is primarily concerned with messages and meanings processes and, at best, only limited integration has taken place with communication and information. (Danesi 2000, 120-121, 205-206).

c) Semiotics/Semiology

Semiotics/Semiology does not represent a precise and highly organized study. There is no single term that can serve as a name and there is no unitary definition of it. Semiology is an European-based term coined by F. Saussure (Culler 1985, 105). It continues to find considerable use in Europe. Semiotics is associated with C. Peirce and more common in North America (Berger 1984, 91). Thomas Sebeok aided in that popularization. (Baer in Krampen 1987, 181 ff).

Definitions display diversity with sign or sign system as a core element in many descriptions. A common definition is "the study of signs." (Chandler 2002, 1). The French semiologist P. Guiraud defined semiology as "the science which studies sign systems." (1975, 1). W. Leeds-Horowitz includes both "the study of signs and sign systems (1993, 6-7). Sebeok offers a broader explanation: "the doctrine, science or theory of signs." (in Blonsky 1985, pg 466). Sign is a vital element in this study though Sign Systems has greater significance in this study. Leeds-Horowitz defines Sign System "as a collection of signs and rules for their use (1993, 6).

Sign as a core term is a mental construct more than physical elements. It includes sign vehicle and the sign process with its signification. Sign vehicle has several descriptions. Morris defines it as a “particular physical event or object” (Morris, 1946, 96, 367 in Nöth 1991, 80). Sign process can be examined under the heading of semiosis.

At the core of semiotics is the idea of semiosis. The coverage of that topic is a reprint from *Foundations* (2013):

The most important term after semiotics is that of semiosis which is concerned with sign process. A succinct definition is found in Sless: “At the heart of semiotics is semiosis -- the process of making and using signs. Semiosis comprises signs, referents and users in an indissoluble triad.” (Sless 1986, 9). Other semiotic writers also employ a semiosis with three elements. However, there can be as many as six components at work. This is especially true of Charles Morris, a pivotal figure in semiotics. Hervey has examined variant formulations in Morris in which there are seemingly five components in his schema (Hervey 1982, 47-48).

A review of the ideas of Morris provide these elements in semiosis: The sign (a mental construct rather than a physical object) stands for something else (the object). The signification of the sign is the meaning that it has in the process. The symbolic construct that is the sign (with its meaning) leads to an interpretant (Nöth 1990, 174; Sless 1986, 9). An example of signification (meaning) is available in marine aids: a red nun buoy stands for the starboard (or right side) of a channel. The

buoy (its redness and shape more than the physical buoy) is also the sign; it stands for the side of the channel, and the interpretant is the disposition to keep the channel, to the right of the vessel. The signification or meaning of the buoy (sign) is: keep that buoy to your right. The interpreter is the party that responds to the interpretant (which is the disposition to a given action not the person responding to the sign). It can be noted that color and shape is part of the sign vehicle as is the physical object.

A second example can be seen in a railway signal with three aspects (each aspect representing one color, and each aspect constituting a sign in its own right though aspects acting together would be a single sign). The green aspect or sign stands for a clear segment of track and it creates a position for a train crew (the interpreter) to proceed through that section of track at the agreed upon maximum speed. More formally, the the signification (or meaning) of green which serves as a sign denoting that the track is free of obstructions. (*Foundations* 2013, 47-48).

One additional component can be added to semiotic: the context of the sign. For Morris context is the “whole situation in which the sign occurs.” (Morris in Hervey 1982, 47). Context is vital for many kinds of T-M forms. For example, buoyage systems follow one of two regions (A and B). The US is in Region B (red to starboard). Starboard navigation begins from the sea and goes to head of navigation. A reverse trip creates a green to starboard meaning. But in Region A (e.g. the Thames in UK) the colors and meanings are the

reverse patterns (IALA Buoyage Conference Report 1980). The review of routeways/travelways in this study comes under the heading of context.

A final term to be included here is that of Code. The term identify signs in groups. Leeds-Hurwitz notes that “[p]lacement of signs into appropriate grouping stresses that *meaning arises not solely, not even primarily, from the relationship of signifier to signified but from relations between signs.*” (Leeds-Hurwitz 1993, 51). T-M in its entirety can be viewed as a sign system though within that specific system are found forms that operate as isolated monads (e.g. a very isolated lighthouse) as well as many that are interrelated so that relations between units are essential (e.g. a mainline railway signal). Code and sign system can be viewed as synonyms. For a crew of a transportation mode it can be said that every T-M form represents an interrelated safety component on a journey even in singular operations.

1A2 Indicators & Other Terms

a) Indicators

A review of signs, their message and meaning content in a T-M context is essential though it does not entirely suffice for this study. How a given contrivance is assembled and how it produces and transmits symbols is equally essential. This segment reviews terminology, the process of generating and transmitting messages and the interaction of device and routeway.

Transmission of a message requires a generating source

for the message to be executed. Generating sources can encompass diverse means including radio transmitters, fixed visual devices, digital technology, signal lamps, acoustic objects among many forms. Many T-M forms also employ a generating source though they are often outside conventional communication technologies (e.g. a buoy with its bell and tappers; a railway light apparatus of lens, light globe and mechanical contrivances). This study could focus primarily on messages and transmissions without a detailed discussion of generating sources and their workings. However, it is important to include that essential undergirding. This is in contrast to many of the past T-M studies which included information on messages and apparatus though the later topic was often of a general nature and within limits.

A basic issue for transmitting messages is that of terminology: What would serve as an adequate term for generating/transmitting source? Terms such as signal, sign or beacon would conjure up images that are deeply embedded. Those terms also encompass more than a generating source. They are also a recognized transportation system. A possible viable usable term is that of Indicator. It can suggest indication (employed in some signal forms for the message and meaning) but with less established images. Indicator may suggest an existing meaning within a transportation mode but it can be expanded to suggest devices outside a specific a mode.

The term indicator appears primarily in one mode, that of railway signalling. It is employed largely for a wide range of specialized signals and what may be termed sub-signals (a specialized signal attached to the mast supporting a standard

signal). Such signals also include various kinds of trackside indicators as well as route and junction indicators. See also studies in the T-M Series and Note 1 in this study.

To borrow the term of indicator for this study may create confusion yet the term has merit for describing the means of creating, generating and transmitting discrete modules of information for all modes. Ch 2A in this study reviews a wide range of indicator apparatus. Non-moving safety aids such as signs and surface markings are also included though they are more of a restricted and passive nature.

To sum up, Transportation-Marking can be defined as an indicator that denotes the validity of accessibility to a routeway. That stems from the 1998 preliminary document on integrative T-M. It may seem a curious construct. However, it was intended to sum up the range of messages and meanings. It may refer to boundaries of a routeway as well as accessibility; both elements interact on each other. Indicators are devices that have the capability of generating and transmitting information. Information is made up of symbols that create messages. Messages with accompanying meaning require a response from the receiver.

Validity of accessibility has two forms: messages that define the boundaries of a routeway, and messages indicating a route-way is available for occupation. Occupation can indicate whether available for occupation or impaired by obstacles. Obstacles include competing modes of transportation, configuration of the route-way, geographical features, human-generated objects.

b) Other Terms

1) Systems

The term System is a commonly employed term with meanings both precise and general. It has been added to the title of this study as well. The meaning tends toward the general because of the breadth of T-M though a measure of precision can be included. A key element in the study are Sign Systems, or Codes, a major form of sign systems. Those topics are discussed in Semiotics/Semiology. The systems applied to T-M requires further coverage since communication and information are integral parts of the study.

Definitions of systems can vary greatly. Nöth notes that “[t]he concept of system most generally implies the idea of elements forming an ordered whole.” (Nöth 1990, 198). He offers a fuller definition from Hall & Fagan. “A system is a set of objects together with relationships between the objects and between their attributes.” (Hall & Fagan, 1956, 18 in Nöth 1990). A more closely integrated definition comes from Ratzan, “[a] consistent, coordinated set of components acting either as a single unit toward a common function or purpose constitutes a system.” (Ratzan 2004, 1).

The previous definitions of system is satisfactory for a specific T-M Sign System (e.g., a general study of international traffic signs) and certainly for a more restricted T-M system (e.g., a specific railway signal code, the IALA buoyage system, or a national aids to navigation system). But a more expanded notion of T-M as a system requires a more general definition of system. A semiotic sense of sign system in T-M may qualify as a specific system even though that

understanding of system may require a more restricted concept.

Communication system and information system are two specific terms within the general concept of system. The former can refer to a limited unit that produces and transmits symbols. This is reflected with this definition: a “facility consisting of the physical plants and equipment for disseminating information.” (The Free Dictionary [Farlex]; see also WordNet 3.0 2006 in Dictionary.com 2008). Information can encompass a larger unit of activity as seen in this definition: “An information system is a consistent, coordinated set of components acting together toward the production, distribution, or processing of information.” (Ratzan 2001, 1).

Communication system is easily applied to T-M since it describes a process that is similar though T-M is a specialized aspect of such a system. Information system may be applied to T-M though in a sense more limited and general.

2) Integrative, ICT & Communication Model

A final term is that of integrative. The term was part of the original title of the study in 1998. At that time the term seemingly received little attention in several “mid-size” dictionaries though some full-scale dictionaries included the word. More recent dictionaries now include the term in print and digital forms. The most helpful has been that of Princeton Wordnet: “combining and coordinating diverse elements into a whole.” (<http://www.definitions.net/definitions/integrative>; <http://wordnet.princeton.edu/>).

Other terms that can have a bearing on T-M are Information and Communications Technology (ICT) and Communication Model. The first term refers in large part to telecommunications technology. It can have application to a broad range of technology that creates equipment and processes for generating and transmitting messages. It is interchangeable with Information Technology. (Wikipedia 2011; Encyclopedia 2.thefreedictionary.com)

Communication Model, can have direct bearing on T-M. It is a concept that overlaps with semiotic constructs. *Foundations* includes coverage of the model that is included in a note at the end of the chapter. See also “Type of Communication Models.” (<http://www.communication-type.com/types-of-communication-models/>)

An additional term is that of Communication Technology. It is the equivalent of Information and Communication Technology. The term includes a broad range of activities as well. (L. Green, 2002, xv). More general terms, Communication System, and Information System are discussed under the heading of Systems.

Note No. 1 Indicators

Indicator is employed as a primary term for all T-M forms in this study. The term has a less significant importance for T-M forms than do signals, signs, beacons. But it is also a safety aid term in contrast to other terms from semiotics, communications and information. The term is not employed in primary (or mainline) T-M uses.

Most Indicators refer to a variety of specialized signals and related contrivances in railways. A few uses of the term are employed in aeronautical T-M systems. It may possibly be a cause of confusion to employ a mode-specific term for an overarching T-M usage. Yet it is more satisfactory than other possibilities. The railroad usage of Indicator is limited when primary and other aids are considered.

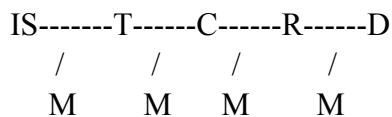
The core term of indicator is only infrequently employed without qualifying words; in fact, a qualifying term often precedes indicator. An exception are the indicators included by Grafton in the late 19th century. That version attached several indicators to a primary signal with each sub-unit marking a separate track while the signal provides a basic message in tandem. (Grafton 1896, 158-159). Grafton's use of Indicator without qualifying term has suggested a possible general term for all of T-M.

There are several Indicator individual forms or groups of forms in use. Many are in UK or nations whose signaling systems were influenced by British engineering and signaling. Track Indicators includes US usage. These include: Route & Junction Indicators, Track Indicators, Switch & Points

Indicators, and Trackside Indicators. Some Indicators in the form of signs are employed in Europe (*European Railway Signalling*, 1995). Other uses are found in switch-related devices, and cab signals. A final example is that of miniature graphic symbols. Nearly 80 forms for railway devices are listed in TM Database: Railways Signals (2009, 276-286). The few aeronautical forms (Landing Direction Indicator, Wind Direction Indicator, Indicator [a term for previous term]) are listed in TB: Database: Aero Nav Aids (2009, 248-250).

Note No. 2 Communication Model
[Reprinted from *T-M Foundations* 2013]

A model often cited in communication theory is that of Shannon and Weaver. Their model constitutes a “communication chain that includes an information source, transmitter, channel, receiver, and destination.” Messages are defined as “a sequence of elementary symbols” and signals “are only the energetic or material vehicles of signs, their physical form” (Nöth 1990, 174-175). A simple representation of the chain can take this appearance:



Messages (M) travel from Information Source (IS) to Transmitter (T) then the Signal (S) proceeds to Channel (C) and thence to Receiver (R) which conveys messages to Destination (D).

The information source is the programming unit. Channel in older models referred to the medium the signal passed through (air, telephone wire, etc.) but for newer models channel refers to characteristics of the signal such as electrical impulses.

The previously described model includes signals which are “the energetic or material vehicles of signs,” though not the signs. The communication model with its information source and transmitter encompasses the total communication process though not the subject matter (Nöth 1990, 174). It includes the element which produces and projects the apparatus as well as the mental dimension.

1B Context: Routeways/Travelways

1B1 Semiotic Context

Context is a component of semiosis (sign process) though only some sources include it. One source is Charles Morris though only one of his three semiosis formulations includes it. Morris notes that “the context in which something functions as a sign may include other signs but need not do so.” (Morris, 1964, 47). Hervey’s summary of the relevant formulation describes the term as the “whole situation in which the sign occurs.” (Hervey 1982, 47).

Earlier editions of *Foundations* failed to include context. That omission may have stemmed from its limited appearance in the literature (The current edition of *Foundations* [2013] includes context). However, it has become apparent that the inclusion of context in some form is necessary. There are situations in which the context of a T-M form (and quite possibly an integrated group of T-M forms) is vital to the understanding of their workings.

The need is notably present with marine aids to navigation because of different systems, and multiple navigation directions. Long-enduring practices, especially in buoyage systems, follow two very different philosophies because of historical exigencies (*T-M: A Historical Survey, 1750-2000*; Ch 3B1, Buoyage and Beaconage Systems, 1924-1957, and Ch 3B2, IALA Buoyage Systems). In some systems red buoys (and other aids of the same color) are to be to the right of a vessel. While other systems employ green to the right or starboard. This situation is compounded by the direction of a

vessel. For example, traveling to head of navigation from seaward places red or green to the right (depending on system). But the reverse journey has the opposite color denoting a given side of the channel. Most red to starboard systems are in the Western Hemisphere while green to starboard systems are largely in the Eastern Hemisphere (Three East Asia states are the exception by using the Western Hemisphere system). Therefore, the context of a given T-M has significance to marine aids to navigation. Coherent messages do exist but only by placing them in their context.

Context can be expanded to all of T-M even if in less noticeable ways. That further context is the routeway (or travelway) in which those forms are situated. Routeways are based on the requirements of modes of transportation. The nature of the T-M forms and their messages are influenced by the context of the routeway. For example, a railway track route way is of a rigid pattern. Trains follow a predetermined pattern in which track and signals have little impact on the track. However, the interaction between modes of transportation has a very significant impact on movements in railroad transportation. This contrasts with buoys that denote the sides of a channel but frequently have little to do with the navigation of ships.

This sub-chapter examines the types of routeways and their characteristics. The impact of routeways on the nature and uses of T-M is also considered. This coverage interacts with the workings of T-M forms and foundations of message categories in Chapter 2.

1B2 Routeway Characteristics

a) Introduction & General Characteristics

Routeways do not exist in isolation. They are linked to the mode of transportation that they serve. Terrain, historical exigencies, relation to vehicles within the mode, non-safety aid message systems all come into play. Routeways are the context of T-M operations. Other factors are also essential dimensions.

1) Routeway Parameters

Routeway parameters have a significant bearing on the context of T-M forms. Major parameters include the degree of rigidity in the routeway, and the nature of vehicular interaction within the routeway. Parameters range from rigid to what might be called porous or indeterminate. Vehicle interaction ranges from extensive in railway transportation to infrequent in marine navigation. The physical environment of the routeway can be significant (e.g., for marine navigation since routeways occupy natural waterways), but less so in railway operations. Road travel includes clearly defined parameters though lacking a rigid pattern. Interactions between vehicles is significant though without the intensity of rail operations. Environmental issues can also be present. Aeronautical navigation includes vehicle interactions akin to roads in ground patterns are found at airports while airborne patterns are somewhat similar to marine routeways though with more vehicle interaction.

2) Supplemental Factors

Message configurations and patterns are not entirely confined to T-M forms. They include rules of the road (in several forms), and onboard navigation systems within transportation modes. They can have a direct bearing on routeways within the context of T-M. The degree of control, rules of the road for operating a vehicle in a routeway and the interaction with other vehicles, and navigation need to be further considered within that perspective.

T-M forms are most present and active in situations that have a substantial control focus. That is the case with railway operations which constitutes an intense control environment including few devices outside of that environment. As the control factor is decreased the presence of other non-T-M safety-related behaviors are increased. For example, while road devices include control devices the presence of guidance, information, and regulatory features have an overarching greater presence. Control devices are a noticeably smaller factor in aero and marine operations. Aeronautical transportation includes a major control factor that is generated by a human-based control system. That system incorporates T-M forms though it is also separate from navigation aids. Marine navigation includes a primary guidance dimension along with shipboard navigation systems. Only limited examples of traffic control lanes are employed.

An additional ingredient of safe transportation are rules that govern the operating of a vehicle. These include basic behavior such as which side of the routeway the vehicle should travel on. The context of the routeway includes the matrix of

operational rule affecting the role of T-M forms as well as the rule in which the vehicles operate.

The term navigation also provides insights into how vehicles function. Navigation can be important in all forms of transportation but it is more significant for aeronautical and marine modes; this is especially true for ships. Onboard devices ranging from ancient devices to electronic mechanisms aid in determining position. While they are not aids to navigation they affect the usage of aids to navigation. Navigation has been greatly affected by the growing use of GPS positioning both in large spaces (the oceans, air space) as well at the level of local navigation which includes T-M aids. McGraw-Hill's AccessScience provides information on navigation in a variety of perspectives: Air Navigation (Studenny, 2008), Marine Navigation (Spalding, et al. 2008), Navigation (Moody, et al. 2008), Traffic-control Systems (Costantino, et al. 2008).

The context of T-M devices represent a complex amalgam. Routeways are significant as the milieu of T-M devices but the nature of operations in a transportation mode, the geography of the routeway, and safety-related devices within vehicles are also present in that integrated mixture.

b) Modal Characteristics

Most marine aids to navigation can be placed under a heading of Guidance Devices (Wright 1997, 125). Devices include those for determining position when approaching coastlines as well as those marking inland channels. GPS has been included in recent years. Channels can also be described

as having an environmental nature since channel markings indicate the environment that is safe for navigation. Boundaries for marine operations are indefinite when contrasted with both rail and road transportation. The latter can greatly affect the context and nature of devices. Aids can also have a warning role that may be apart from guidance. The previous source also speaks of “[m]aneuvering controls” that refers to rules for the road rather than guidance devices.

Road safety aids also include a significant degree of control. However, that is only one of several functions. Other functions include three primary dimensions: devices for guiding, regulating and warning. They apply most directly to traffic signs which are divided into three forms. Road markings are viewed as a means of guidance. Markers also channel traffic; that probably constitutes a form of guidance. Traffic signals are obviously control orientated but they can be described in other terms including guidance, regulations and warning roles (Costantino 2008, 3). The control function remains at the core of those activities. Traffic Control Devices is the basic term for road aids and that underscores control as a primary function.

Railway operations are based on rigid parameters which are coupled with signals thereby creating a high level of control. Signals create a safe environment by spacing of trains as well as moving trains to adjoining tracks. Simple unlighted devices provide a similar function for sidings. A smaller segment of signs and markings provide guidance, information and regulatory functions; they also can affect the primary role of control. Operating rules and time tables provide safe passage on lightly used tracks.

Aeronautical routeways can present a complex picture. Airport lighting and markings bear some resemblance to marine settings while various electronic aids provide airport approaches. Radio aids are employed away from airports. These aids provide position information. However, routeways and safety devices are altered by the place of airport traffic control that adds direct human and electronic dimensions to aero navigation. Nonetheless, navigation aids carry out a vital guidance function. Aircraft navigation as well as marine operations contain onboard systems that affect the use of safety aids.

Note

The first edition of this monograph adds Travelway to a long enduring term, Routeway. The term Travelway refers to transportation modes and the “route they travel.” (Hoel, Garber, Sadek 2008, ix). The older term of Routeway first appears in *Foundations* (2nd edition, 1991). Source of the term is unknown; routeway rarely appears in transportation literature. Sub-terms include a variety of terms: airways, railways, roadways, and waterways. These terms can have a variety of uses and definitions.

CHAPTER TWO

INDICATORS, MESSAGES, MEANINGS

2A Foundations

2A1 Basic Messages Categories

This chapter focusses on the generation and transmission of messages. It also examines the meaning of messages. It is not entirely an abstract discussion of the process since the technology of the indicator is included. That technology ranges from a simple light with a fixed character to complex satellite mechanisms. It also includes passive generating devices. The generating aspect is divided into four categories. The categories are based on the foundations of message categories developed in early T-M studies in the 1970s. They are not messages in themselves but rather subdivisions in which messages can be classified and described.

The description of the foundations of messages is reprinted from *T-M Foundations* (5th ed, 2013):

“Pre-semiotic” Foundations of Messages in this view can be viewed in a different perspective than that of older editions of this study. The older editions did not see messages in a T-M perspective as being semiotic messages. However, this “pre-semiotic” material can be seen as categories within which the various messages are generated, emitted, and transmitted thereby creating a disposition (interpretant) to the interpreter or user. Messages are essential in models of communication perspective.

Messages are not a purely theoretical construct. Instead, foundations of messages construct a bridge linking semiotics, the physical signal and the transportation mode together. Foundations also touch on all aspects of the study including that of taxonomy since the classification of messages is linked to T-M forms classification.

Transportation-Marking messages can be reduced to four major forms:

1. Multiple capability that permits **Changing Message/Multiple Message (C3M)**
2. Message capability that permits only **Changing Message/Single Message (CMSM)**
3. Message capability that includes an **Unchanging Message but with Multiple Messages (U3M)**.
4. Message capability that is restricted to **Unchanging Message & Single Message (UMSM)**.

Marking messages have a dialectical character about them: unchanging or changing; multiple message or a single message. All of the possibilities are combinations of one member of each of the two sets of the dialectic.

The most frequent type of changing message/multiple message (C3M) are those of road and rail lighted signals. In these instances the message has several phase or sub-messages which change according to pre-programming, transportation mode-initiated change, or central control. The basic signal for rail and road contains three-lenses displaying red, green, and yellow hues. The meaning of multiple-messages refer to various messages from a single marking. Changing refers to the situation in which

the message alternate or change according to an established pattern. A marine light may have a complex message but, nonetheless, it is a single sequence or period which indicates one message. There are few examples of C3M outside of road and rail signals. Other varieties of railway signals (search-light, position, color-position) follow the C3M pattern though the manner of executing of the message varies from one signal type to the next.

The changing message/single message (CMSM) type suggests a contradiction since change and a single message sequence are in one message formulation. A reasonable explanation is possible: some markings contain one message but that message is not continuous. For example, a road signal at a school may only operate during school hours, or a drawbridge signal may function only when the lift span is raised. The signal, when inoperative, creates a different pattern of traffic than when on.

An apparently contradictory nature may also seem present in the changing message/multiple message from (USM). This category refers to situations where at least two distinct messages are found within a single marking. For example, the device known as a “traffic beacon” has an unchanging message yet two messages are displayed: one a flashing yellow indication denoting caution, the other, a flashing red indication denoting stop and then proceed only when the intersection is clear. A second example is the marine light known as a directional light. It emits messages for two or three zones within a single channel simultaneously.

Unchanging message/single message (UMSM) is self explanatory. It includes the greater part of marine and aero markings as well as many unlighted and partially-lighted road and rail markings. The UMSM type has one sequence which is unvarying in all cases. However, in the monograph on traffic control devices (1st ed, 1984; 2nd ed, 2004) it became apparent that some very different forms of markings were merged together in the UMSM category. The following paragraphs outline needed changes in UMSM. The changes are extended to other T-M studies.

The members of UMSM exhibit one of two messages characteristics: they either produce one message at a time (though other messages could be programmed for the mechanism) or they produce a single message and are incapable of any other message. The former sub-category can be termed “Programmed Transportation-Markings” while the remainder of forms can be denoted “United Markings.”

The unitary group can be further divided into: a) some markings have a single form and admit no variation; these are termed “Variant A”; b) an intermediate group allows for one of several predictable variations and these are subsumed under “Variant B”; c) these include markings about which few, if any, predictions can be made and are labelled “Variant C.” A stop sign clearly suggests the “A” variant; a turn sign (displaying one of several types of turns) represents “B” while sign denoting the name of a town indicates the “C” form. A fourth variant, “D”, has been added to accomodate the individual form of GPS.

A programmable marking, such as a marine light, can not be easily subdivided. The relevant marine agency may publish a listing of the spectrum of light phase characteristics. But the actual light/dark sequence is an individualized process and the observer would have to examine many individual lights in order to gain an appreciation of the categories of messages.

2A2 Indicators as Physical Objects & Their Placement in Message Categories

An introduction for Indicators is provided for in Chapter 1A. That coverage focussed on terminology. This material discusses the general character of Indicator forms and their placement within the foundation message categories.

Indicators can be of two basic forms: active and passive. The former is a mechanism which produces a transmission. The latter is a passive agent whose means of generating and transmitting is pre-formed and remains stationary though functioning. Many traffic signs, unlighted beacons, surface markings, and non-lighted hazard markers are examples of the second form.

Brief technical description of the indicators are included here. Indicators can be merged when similar; nuanced differences are added as needed. The sources for the indicators are the T-M modes. While the modes are not a determining factor in the description and location of the indicators they are a secondary point of differentiation.

The categories are divided into two forms of multiple

messages and two forms of single messages; one of the single messages forms is divided into further subdivisions. The types of indicators are listed within the appropriate niche.

Indicators are divided according to categories of the foundations of messages. The secondary criteria for arrangements is the nature of the physical apparatus. There is also a need for references to physical and transportation contexts. The entries describe the physical features of the indicator and means of transmission. Messages and meaning are considered separately though they remain in close proximity to the indicator dimension.

2A3 Formulation of the Nature of Messages & Types

This segment reprints the formulation for the nature of messages of Part H, 2010. A variant “D” has been added to 24; Types with code numbers and names have been revamped and expanded.

This classification is based on the nature of messages found in the subject monographs. Messages are arranged according to the form of energy and by modes. It assigns a category to each marking. The classification employs a number-only designation though the letter and word designations originally employed can be substituted.

The formulation includes:

1. for changing messages
2. for unchanging
3. for multiple messages
4. for single messages

Two digit indicators include 13 which indicates changing message, multiple message (C3M). 14 denotes changing yet single messages (CMSM). 14 is divided into 14.1 for unitary messages, and 14.2 for variable messages. 23 denotes unchanging message with multiple messages (U3M). 24 denotes unchanging message with single message (UMSM); 24 has two sub-forms: a basic bifurcation into programmable markings (.1), and unitary markings (.2). Unitary exhibits one of three subdivisions: variant A (24.2.1) which admits of no variations; variant B (24.2.3) can display one of several predictable forms; variant C (24.2.3) can accept any number of forms; variant D (24.2.3) refers to situations such as GPS where messages are individualized. This results in these possible designations for the classifications: Type 13, Type 14, and Type 24 divided into 24.1, and 24.2.1, 24.2.2, 24.2.3 and 24.2.4.

A summary of this classification has this appearance:

- 1 = Changing Message (CM)
- 2 = Unchanging Message (UM)
- 3 = Multiple Message (MM)
- 4 = Single Message (SM)

- 13 C3M (alternate formulation: CMMM)
- 14 CMSM
 - 14.1 = Unitary
 - 14.2 = Variable
- 23 U3M (UMMM)
- 24 USM
 - Programmable 24.1

Unitary 24.2

subforms:

Variant A 24.2.1

B 24.2.2

C 24.2.3

D 24.2.4

Type 13

2100 Traffic Control Signals, Marine

326 Aircraft Stand Aids

411 Standard Signals, Road

412 Special Signals (selected forms; see Notes)

4122 Level/Grade Crossing Signals

4123 Lane-Use Control Signals

4126 Ramp-Control Signals (see Note)

4410 Audible Pedestrian Signals

511 Trackside Signals

512 Cab Signals

513 Dwarf Signals

521 Trackside Signals--Semaphores

522 Signal Boards/Board Signals

523 Dwarf Semaphore & Rotating Signals

524 Dwarf Revolving Signals

531 Targets & Track Indicators

5610 Cab Signals/Audible Cab Signals

5611 LC/GC Lighted Signals (Crossing Bells)

5620 LC/GC Lighted Signals/Unlighted Signs

5621 Barriers & Gates

Type 14

14.1

- 4121 Flashing Beacons (Hazard Identification Beacon, Speed Limit Beacon, Stop Sign Beacon in variant classification: Traffic Beacons)
- 4124 Movable Bridge Signals
- 4125 Emergency Signals
- 4127 Miscellaneous Signals (Ferry Boat Landing Signal; Low-Flying Aircraft Signal in variant classification)
- 4400 Movable Bridge Signals (sound dimension is given separate listing: 5401 LC/GC Bells)

14.2

- 4121 Flashing Beacon (Intersection Control Beacon in variant classification: Traffic Beacons)

Type 23

- 160 Large Floating Aids, Single
- 161 Lighted Sound Buoys
- 2101 Sector Lights, Marine

Type 24

24.1

221 Major Structures (Lighthouses): Sea-girt
222 Major Structures: Land-based Towers
223 Major Structures: Non-Towers
224 Minor Structures
240 Signals with Single Forms, Fixed Fog Signals
241 Signals with Variant Forms, Fixed Fog Signals
 (seenote)
1500 Radar Beacon Buoy
2500 Radiobeacon
2510 Racon
2511 Ramark

24.2.1

120 Standard Single Types, Lighted Floating Aids
130 Standard Single Forms, Unlighted Buoys
140 Single Types, Sound Buoys
160 Large Floating Aids, Single Types
161 Lighted Sound Buoys
240 Signals with Single Forms, Fixed Fog Signals
241 Signals with Variant Forms, Fixed Fog Signals
2512 Radar Reflectors
252 Hyperbolic Navigation Systems
311 Approach Lamps
312 Final Approach Indicators
321 Runway & Taxiway Inset (Inpavement) Lights
322 Runway & Taxiway Elevated Lights
323 Beacons
324 Obstruction Lighting
325 Wind Indicators
327 Heliport Lights

4128 Lighting Devices
5400 Detonators
5401 LC/GC Bells
5410 Track Crew Warning Signals

24.2.2

131 Forms with Variant Versions, Unlighted Buoys
231 Natural Marks, Unlighted Marine Fixed Aids
232 “Artificial” Marks, Unlighted Marine Fixed Aids
233 Morphological/Physical Forms, See Note
330 Signs-Single Forms, Unlighted Aero Nav Aids
331 Signs with Variant Versions, Unlighted Aero Nav
Aids
332 Markings
333 Obstruction Markings
334 Elevated Markers
335 Low-Elevation Markers
431 Warning Signs, Unlighted TCD Signs & Markings
432 Regulatory Signs
434 Horizontal Markings
435 Vertical Markings
533 Markings
534 Fixed Unlighted Signals, Railway Sound Signals

24.2.3

328 Partially-Lighted Signs
433 Informative Signs

4333 Signs Giving Information
5250 Lighted Signs, Single Form
532, Signs, Unlighted Railway Signals, Signs
5250 Single Forms, Lighted Signs
533 Markings

24.2.4

3530 Global Positioning System (GPS)
3531 Differential GPS

Notes

These notes follow the outline of the main classification. That is also true of the types of messages except that the message classifications are arranged by types while the notes follow the message classification directly. Several general notes regarding changes in terms have been added. These are generated by the classification.

311 Approach Lamps. A coding of 24.2.1 is more accurate than 24.1 since they are fixed rather than programmed.

312 Final Approach Indicators are also 24.2.1. They have a single message though in three phases.

411 Traffic Signals, Standard are 13.

412 Complex entries employ 14.1, 14.2 as well as 13. Only sub-divisions are not listed here.

4126 Rampside-Control Signals. This version from the 1st ed. is altered in the current Classification: Ramp replaced Ramp-side; “side” is deleted.

4128 Lighted Devices. These TCD devices in the classification have two forms: partially-lighted and all-lighted. 4128 referred to all-lighted and 421 included a variety of “partially-lighted.” However, it has become clear that all forms are all-lighted. There is no unlighted day traffic control safety dimension for any of the devices. Some of the devices are on around the clock while the others are on only during the night. They should be together though in two segments. Any additional work on the classification would delete this form of “Partially-Light” and reformulate the night-only form of the all-lighted version in order to accommodate that form.

511, 512, 513 Code 13 employed for the three segments.

160, 161 Two or more messages are integrated. Coding is 23.
161: Lighted Whistle Buoy in Classification should be Lighted Sound Buoy.

221-224 Day as well as lighted forms use employ code 24. It may be to add a dual message code.

321-325, 327 Coding is assigned to 24.2.1 save for Identification (Code) Beacon when employed in that function. It is then coded as 24.1

326 Segment follows 13 rather than above codes.

328 Code is 24.2.3 because Partially-Lighted Signs can include a wide variety.

421 Lighting Devices: see 4128.

5250 Lighted Signs, Railway Signals include a variety of forms so that 24.2.3 is appropriate. Classification has a variant form of the 1st ed of this study: Single Forms, Lighted Signs.

130 Standard Single Forms, Unlighted Buoys are represented by 24.2.1 since the basic shape is a single form though differences in shape and size can be present.

131 Forms with Variant Version, Unlighted Buoys is included in 24.2.2. because there are basic variants.

231 Natural Marks follow primary shapes but variations can be present; 24.2.2 is therefore employed.

232 Artificial Marks classify forms by categories. 24.2.2. code is used here as well.

233 Morphological/Physical Forms include daymarks and daymarks & structure. It is coded under 24.2.2 though 24.2.3 may be more accurate.

330-335. Unlighted Aero Navigation Aids includes diverse forms. Many aids can be coded as 24.2.2. though some may possibly be single forms and others very diverse forms. Two forms have a modified version from the classification: Signs-Single Forms, Unlighted Aero Nav Aids, and Signs with

Variant Versions, Unlighted Aero Nav Aids.

431-432 Warning and Regulatory signs are listed as 24.2.2. Again, some components are more diverse.

433 Informative Signs represent the same challenge whether some diversity or considerable diversity. There is a tendency toward 24.2.3 more than 24.2.2. Signs Giving General Information, 4333, uses 24.2.3.

434 Horizontal Markings is coded as 24.2.2 which may be accurate in many situations.

435 Vertical Markings contains several groups of safety aids; 24.2.2 may be workable here.

531 Targets & Track Indicators are Type 13 within Unlighted Railway Signals.

532 Signs include many diverse forms which can be coded as 24.2.3.

533 Markings includes several forms. Diversity is present though to a moderate degree. They are listed as 24.2.2.

534 Fixed Unlighted Signals are found in UK. They are a signal with a single message. 14 should be a satisfactory code.

140 Sound Buoys are generally non-programmed types and thereby coded as 24.2.1. Any programmed forms would be 24.1.

161 Lighted Sound Buoys are listed as 23 denoting multiple messages that are separate though integrated.

240, 241 Fog Signals are substantially 24.1 though any non-programmed versions would be 24.2.1.

4400 Movable Bridge Signal can be viewed as 14.1 since it has an active message and a passive message.

4410 Audible Pedestrian Signals is coded as 13 since it is full-time and integrated with the visual dimension of the signal.

5400 Detonators is coded as 24.2.1 though a more nuanced designation would be preferable.

5401 LC/GC Bells may be present with lighted signals and signs though they may also be separate units. Coding for the bells alone is 24.2.1.

2A4 Small Categories of Messages

Originally it was deemed necessary to have four sub-chapters for Foundations of Messages:

- Changing Messages/Multiple Messages
- Changing Messages/Single Messages
- Unchanging Messages/Single Messages
- Unchanging Messages/Multiple Messages

However, the second and fourth formulations were very small and required little coverage. Changing Messages/Multiple Messages includes signals that are operational only

part time. This suggests a changing message that has one form since it is shut off for periods of time. The absence of a message is a form of passive message.

Unchanging Messages/Multiple Messages refers to forms that have distinct messages within a single aid. Directional lights are also included though it is questionable whether it should be considered as a multiple message. It may be closer to a multi-faceted single message.

All of the components are represented in this study. Though the nuanced dimension needs attention. One form of Flashing Beacon (TCD) includes changing messages though they are single messages in one housing and at one installation. Special Traffic Signals also contain a different version. For example, school crossing signals, emergency signals, movable bridge signals are part-time active with the off position constituting a passive message (*T-M Database: TCD 2008, 202-210*).

Unchanging messages with multiple messages are limited. They include buoys with double message producing elements (e.g. lighted sound buoy). Messages are both visual and acoustic. One might argue that any lighted buoy is two-dimensional since the visual aspect is bifurcated. However, in this study visual is one dimension and sound or electronic are separate dimensions. Lightships and light floats are other forms. Marine sector lights may possibly constitute another form since the principal light has one function while the sector light has a second and specialized role. Directional lights are probably a single message though multi-faceted (*International Marine A/Ns 2010, 54-55, 143*).

2B Unchanging Messages/Single Messages

2B1 Indicators

a) Visual Indicators

1) Introduction

Unchanging messages/Single messages (UMSM) include T-M forms that display a single, unvarying message. There are some forms that have multiple messages in an unchanging format but those forms are relatively rare. They are reviewed later in this sub-chapter. The diversity of Unchanging Messages has a very broad range. Yet the core element of shared message configurations can unite the diverse forms.

Indicators need to be subdivided according to Unchanging Messages within the classification message schema (UMSM) with its sub-categories of Programmed and Unitary (3 forms). They also need to be subdivided into fully-lighted, partially-lighted and infrequently unlighted forms. A major issue is the split of many message-producing indicators into lighted and unlighted segments. It is possible that the day part can be integrated with the lighted part even with forms that are nearly all lighted and with a miniscule portion (or indirectly day-enhanced). The initial topic of this segment considers that issue.

Visual indicators often include a day dimension for many forms including all-lighted versions. The day aspect is

significant even though the lighted portion is primary. The day aspect is a message producer in tandem with the lighted part.

UMSM consists of a broad range of T-M forms including land-, water-, space-based indicators. Some are visual forms (unlighted, partially- and fully-lighted) while others are acoustic and electronic. The components of UMSM include passive objects with an unvarying message. It also includes active forms encompassing programmable indicators and a wide spectrum of unitary indicators that include forms with variations. All transportation modes are included in UMSM.

Programmable forms are a common element of lighted, electronic and acoustic forms. Unlighted visual forms are less likely to be programmed. Unitary forms consist of three forms: variations, limited variations, and diverse forms. Programmable originally referred only to T-M forms that employed light phase characteristics (fog signals can have an acoustic equivalent). However, there are other meanings of programmed. They include indicators (often aero) that can be adapted for a variety of functions (e.g., a runway light fixture can be employed for threshold/runway end lights). Color fixtures are also a kind of programming. Explanations of the classification needs to be modified to include variant approaches.

2) Day-Night Aspects of T-M Forms

Visual indicators often include a day dimension for many forms including all-lighted versions. The day aspect is a

message producer in tandem with the lighted part. Some day dimensions are integrally a part of the message producing contrivances and thereby a component in the production of messages.

However, substantial structural components of fully- and partially-lighted indicators can become an “unofficial” message producer. For example, a substantial support structure for aero approach lights, which is physically adjacent to aviation activities, can be painted international orange since it becomes an obstruction to navigation (and thereby a navigation aid). The previous remark is largely directed to messages and meanings though it also refers to indicators. Marine aids include the day portion of towers, buoys and other structures as part of the message process. Some are a formal daymark while the structure for the light in itself serves as a daymark. The coverage may focus more on the lighted element yet official and unofficial structures need to be included.

Some light indicators lack a structure that can serve as a day dimension. For example, aero lights that are inset or above ground with only a short stem to support the light. Surface markings, which are separate, serve as the day portion. Such aids are termed partially-lighted since the light unit lacks a day-capacity either lighted or a day marking contrivance.

The situation can be presented in an outline formulation:

- Fully-lighted (24/7). The structure is not a dimension of the device (as is the case with marine a/ns) though

it can constitute an obstruction marking. It may represent a kind of semiotics of the object.

-Partially-lighted (Less than 24/7).

-With day dimension. It can be divided into:

-Fully-integrated (e.g. buoys)

-Substantially-integrated (e.g. lighthouse)

-Daymarks may be comprised of existing structure. Or it may be a separate and “official” daymark.

-Without day dimension. In these instances there is no structure which serves as a defacto day mark. A lamp, for example, with housing on a very short support can be defined as a structure but not a structure which constitutes a support for lamp and immediate appurtenances. It became a common practice to paint housing and supports (e.g., stems) in aviation yellow thereby producing a limited day-marking.

Note: A device without any day dimension can be viewed as a fully-lighted T-M entity. For example, some temporary TCD warning lights operate at night and there is no day operation. Neither is there any day dimension that can serve as a form of daymark. Other TCD lights function day and night and are fully-lighted in a recognized manner. Some distinction in the classification may be in order to distinguish these forms.

b) Fully-Lighted Forms

Approach Lighting includes an unidirectional lamp, an omnidirectional lamp, and a sequence flashing light. The first unit is for high intensity usage. The omnidirectional lamp bears some resemblance to runway lamps with short stem and lens. The third unit, the sequence flashing light, is also termed a capacitor discharge light and is unidirectional with xenon lamp. (Danaid 1991).

Final Approach Indicators include a diverse variety of forms that date back to the 1930s. The Indicators create messages that provide information on descent paths. There are approximately five essential forms. There are also variant forms and less employed units. (Clark & Antonenko 1993, 51; Clark & Gordon 1981, 1).

A long-enduring form is that of VASI (Visual Approach Slope Indicators). The 2-Bar version is the basic type while more complex versions are in use. 2-Bar refers to two boxes containing the needed lights. It includes lamps, spreader lens and a narrow slit aperture through which messages are emitted. (*International Aeronautical T-M* 1994, 99).

PLASI (Pulse Light Approach Slope Indicator) operates from a single box with a single lamp. Descent location presents one of four messages. Messages can be steady or pulsing. (Devore 1991).

PAPI (Precision Approach Path Indicator) contains a single box with two or four lamps. The assembly contains reflectors, lamp holders, and quartz lamp. Other features

include filter, lenses, and front glass. (Flightlight 2009).

Tri-Color Systems (no acronym) is a one light unit operation. Messages denote descent location through colors. Two recent versions are Glide Path Indicator (GPI) and Tactical Portable Approach Slope Indicator (T-PASI). GPI is also known as the Helicopter Glide Path Indicator. (*T-M DB: Aero* 2009). T-PASI consists of an elongated and rectangular box including lens, reflector, multi-color filters, halogen bulb (Danaid 1991).

Alignment of Elements system (AOE) is either a day-only or a partially lighted system. It consists of plywood panels painted either fluorescent orange or black and white. Lights may be included for night-time use. It provides information for approaching the runway correctly (FAA AIP 1999, 12.2.5).

c) Partly-Lighted Forms

This monograph focusses on T-M as a discipline or at least a coherent account of indicators and messages. That is reasonably feasible in changing forms since there are standardized contrivances for creating and transmitting messages. Attention to mode-specific issues is a limited factor for those forms. However, partly-lighted forms are often unchanging and they include many diverse contrivances for the same purpose. There is also more emphasis on mode concerns. Coherence is not lacking but it is reduced. This coverage begins with marine forms followed by aero forms and completed by a limited number of road forms.

A key concern for marine indicators is that of the lighting apparatus. These forms can be divided into minor forms and major forms. Marine lanterns can manifest a variety of forms. Some forms consist of a metal base with glass or acrylic cover. The cover not infrequently doubles as a lens which is often of a fresnel design. Electric lamps traditionally employed incandescent light bulbs. These have declined in use as halogen and other forms have increased. In more recent years LEDs (light emitting diodes) have increased in usage. Newer lanterns often employ solar energy. Some marine forms are relatively short range. Floating aids employ some of the smaller lantern units employed for land-based installations. (USCG 1964, Ch 5; Pharos marine ca1991; Condren 2001 [LEDS]).

Larger light apparatus are exemplified by classical lighthouse apparatus with lantern house and hand-crafted fresnel lenses. This form rotates on a mechanical apparatus (Sutton-Jones 1985, 96-107). With time, lenses became more complex and more efficient lights are developed. Double-ended beacons employed in aviation have been used in replacement situations. These are frequently double-ended rotating units (USCG 1964, 5-12-13).

Message production require coding devices which create light phase characteristics. These can also be achieved by a rotating apparatus. Other forms include flasher producing devices that can create the desired characteristic. (USCG 1964, 5-1-2).

The lighting mechanism is supported by structures of diverse designs. Smaller lights frequently are augmented by

officially designed daymarks. The structure can have a secondary role or it may be substantially obscured. Traditional lighthouses have distinctive structures readily identified. (*International Marine A/N* 2010, 142-146).

Airport indicators are comprised in large part of runway and taxiway units. They are arranged in a design requiring substantial numbers of similar devices. There is a limited range of indicators since the devices are often employed for several functions. Simple forms can be distinguished from complex versions though the design and elements are similar. There are two primary forms in use: elevated indicators and inset indicators.

Elevated indicators are low level devices situated at the boundaries of a runway or taxiway. Edge forms can be employed for a variety of functions. They consist of a globe which displays a fresnel lens form. The units are frequently omni-directional though some bi-directional units are employed in use. High intensity forms contain an outer globe and an inner lens. Message requirements dictate the use of color. The lights are fixed in character (i.e., the light does not flash or revolve). They lack a structure that can be seen as a day dimension. It may be possible to regard the miniscule physical apparatus and its coloring as a T-M form to a limited degree. The day dimension of runway and taxiway indicators are separate surface markings. (*Flightlight* 2011; *International Aero. T-M* 1994, 105-07).

Inset lights are units nearly flush with the surrounding pavement. These aids emit messages which overlap with elevated versions. Other messages are independent of above

ground aids. There is a sturdy outer cover that includes openings for the lamp lenses. Optical and lamp assemblies are located within the below surface housing. Lamps employ quartz halogen. Inset lights can be omnidirectional, bidirectional or unidirectional. (*International Aero. T-M* 1994, 102-104; Cegelec 1992).

Beacons for aviation use continue to employ traditional forms that date back to the 1930s along with more contemporary forms and updating of old forms. A basic airport identification beacon is a double-ended rotating beacon of large diameter. The device includes an outer clear lens and inner doublet lens in color. The beacon apparatus is linked to a housing that includes mechanism and motor for rotation. Incandescent light bulbs have been replaced by metal halide lamps in some modern versions. A variety of light sources have undergone change for many safety aids. Maritime agencies have employed new versions of the beacon that includes metal halide lamps and reflectors in place of fresnel lenses. (CAA- 446, 1942; Crouse-Hinds 1962; ADB ca1991; USCG 1964, Ch 5).

A second historic beacon goes under several names including code beacon (H & P), hazard beacon (NATO 1992) or Morse code omnidirectional identification beacon (ICAO Lexicon 1986 for core term). It is a vertical unit largely made up of fresnel lens and includes color filters and an incandescent lamps. A coder device attached to the lamp programs the lamp characteristics. (Crouse-Hinds 1962).

Obstruction lights include simple devices as well as complex units including the hazard or code beacon. The

simple version displays a globe in fresnel design and the lamp is fixed or steady-burning. New versions of simple lights include steady burning neon lamps that can, in some cases, receive their power from an adjoining power line. There is an increasing use of strobe lights for flashing lamps. High intensity versions display an uni-directional message intensity while medium intensity forms are omnidirectional. Control devices can increase or decrease the intensity of the lights enabling the device to be employed continuously. Some obstruction lights are partially-lighted while others are fully-lighted. Message configurations are uniform despite the character of the light. Some beacons of similar form can be programmed for other functions. (FAA 1991 OML, ICAO, ADM 1983 24-25, ADB 1992).

Wind Tees is an older device with decreasing usage. It displays the form of a "T" outlined by fixed lights. Wind Cones indicate wind directions. It is indirectly lighted and displays an aid to navigation function. (FAA 1965, Crouse-Hinds 1962, Danaid 1990).

d) Unlighted Forms

Unlighted indicator forms represent a complex issue. Materials can vary greatly for these indicators with the various modes over time though an increasing standardization has taken place. Some forms are interwoven with lighted forms. Indicators are technically precise while other forms have an organic, historic character that is not easily described especially when local in nature.

A survey of unlighted forms includes a review of

forms employed for indicators, the place of reflectorized materials, and the shapes of indicator forms. Unlighted forms include signs, marks and markers, surface markings, and structures. These terms have complex and frequently uncertain meanings. A simple sketch of major forms may suggest a panorama of forms. Signs are frequently vertical objects that can display alphanumeric symbols and graphics in some instances. Message configurations do not always occupy the entire surface of the board underlying the message. Marks and markers, in contrast with signs, frequently cover the surface. These devices are often vertical in shape and can range from short to tall. Surface markings are found mostly in aero and road forms and can include graphic and alphanumeric forms. Many indicators are of a structural shape. The term refers to more complex devices which comprise the indicator rather than serve as a support. Other forms are little more than a board. The four categories described represent a broad spectrum though not an exhaustive review of possible dimensions.

Unlighted forms are relatively simple in their physical makeup. Messages and meanings are a far more complex issue. Materials and design of sign and marking forms exhibits a similar pattern for all T-M situations. Newer technologies have created new materials though basic materials are in use. The underlayers for signs and larger panels employ a variety of materials including plywood and metal (steel, aluminum, and iron at an earlier time). Posts and similar supports also are made of wood and metal. Mast arms, sign bridges and complex frameworks are of metal construction. Terms for background materials go by several names include backing for marine usage (USCG 1964. Chs 4, 5, 8), and sign blanks for

road usage (US TCD *Handbook* 1983, 2-27).

Reflectorization process has become a major material for producing and displaying messages. Sources often refer to retroreflective sheeting though USCG refers to fluorescent films for dayboards and retro-reflective materials for alphanumeric symbols and borders (USCG 1979, 5-17).

Shapes for indicators include the range of geometric shapes. There are, however, guidelines for shapes in different modes and systems. For examples, aero signs, according to ICAO guidelines, are rectangular in shape (ICAO 1999 AD I, 80. US *MUTCD* has a complex schema for signs that include primary shapes for different configuration of signs (e.g., diamond-shaped signs for warning signs) (1978, 2A-4--2A-5). Railway signs in diverse system often include rectangular-shaped signs (AREA 1929). Daymarks also display shapes according to an approved pattern. (Canada 1975). Shape is one dimension of an indicator and its messages. The symbolic aspect includes the physical dimension; it can also be said that the symbolic goes beyond the physical shape in creating message with their accompanying messages.

Remarks about marks and markers are somewhat similar to those about signs though message construction can be at variance with many signs. A more striking difference is found with surface markings. They are employed in aero and roads and are fully unlighted. Various materials including paints, thermoplastic materials, and reflectorized materials are employed. Low-level markers can be included for some uses. Remaining forms include traditional daybeacons and the markings of obstructions. Those forms center on painting of

structures that can be a danger to aviation. The former requires more explanation (T-M Studies).

Historic forms of daybeacons consisted of diverse structures. In these cases the structure was the aid. Daymarks did not dominant and may have been rare. Older daybeacon forms included objects such as cairns, tree branches, trees and large timbered constructions. It is not readily known how much current usage these older forms have. However, structures of many designs old and new are in use. Contemporary practice tends to add daymarks to structures. Such daymarks are also indicators in themselves. Daymarks are more often part of a system of buoyage and beaconage than in the past.

Terms can become embroiled in semantics (e.g., are posts, perches, poles similar or identical despite variant names?). It may be a better course to speak of unidimensional and multi-dimensional forms. Daybeacons may have structures similar to lighted harbor and even coastal lighted aids. Those forms with lights are reviewed separately.

Messages and meanings can create a coherent system for daybeacons despite diverse physical forms that labor under a welter of terms. The forms can range from technical contemporary to old and simple. These are similar message constructs for channel markers, obstruction markings, and position aids. This is also true of meanings.

e) Acoustic Indicators

Acoustic signals are substantially a marine precinct. Pedestrian and railway crossing sound signals are employed,

but they are generally found with changing messages. This is also true of cab signals. Explosive signals find some use in railways and these are unchanging message forms. Decades ago an aviation fog signal of sorts underwent experimental work. It may have had a short life (Sonic Marker Beacon, SA July 1933, 22).

Many types of marine sound signals are now out of service. And sheer numbers of signals have vanished. Limited signals of a standardized nature are still employed. Buoy-based signals continue to be a relatively large system. Nonetheless, not so long ago a large and diverse system of fog or (sound) signals was in existence. Despite the near extinction the defunct forms represent a communication, information and semiotic system of significance. The diverse types of indicators created many kinds of sounds. Message and meaning coverage can link the indicators together.

Descriptions of how the sounds were created does not describe the distinctive sound. Nonetheless, the sound creating process does indicate the how of a distinctive sound message for various fog signal forms.

Sirens: Steam, compressed-air or electricity activated a disk with slits or a rotor thereby creating a distinctive sound. Many siren fog signals were originally powered by steam. More recent forms employed compressed-air and electric sirens, in turn, replaced that means of propulsion.

Whistles included wave-activated forms though many other forms were capable of coded messages. These forms were created by movement of steam or compressed air through an aperture in the whistle body.

Reed horns consisted of a reed placed in a large trumpet that was activated by steam or compressed-air blowing through the trumpet thereby activating the reed.

Bell signals were capable of coded messages when activated by a clock-work mechanism or a more modern bell striker device. Wave-activated bells provide random action.

Diaphragm Horns involve vibrating of a diaphragm by the use of compressed air, steam or electricity. The electric version that employs an electromagnetic oscillation method has become the primary sound form in use.

Explosive Signals employed a variety of means. Older versions included the use of cannon. More recent versions included a signal involving a tonite charge, jib and detonator. Acetylene gas guns created an explosion by mixing of acetylene gas with air.

Diaphones, technically known as a reciprocating siren, produced sound by the moving of a slotted piston by compressed air or steam. The sound is similar to that of a siren but produced by a piston rather than a rotor.

Gongs are primarily a buoy-based aid and not a programmed entity. When aboard gongs could be coded. Gongs and bells are available in electronic simulations.

Submarine Signals employed compressed-air and diaphragm version as well as wave-activated forms. Some devices included a coded characteristic.

Source materials for this segment include *International Marine A/N* 2010, and *T-M Database* 2007 (Ii). An extensive treatise on fog signals is found in Alan Renton's *Lost Sounds: The Story of Coast Fog Signals*, 2001.

Railways have employed a form of fog signal which

includes low-visibility) conditions. The aid has several names including Detonator and Fog Detonator. A train approaching a signal in poor weather would be warned of the signal by triggering a detonator attached to the track (Blythe 1951, 104).

f) Electronic Aids

Electronic aids represent a diverse range of forms. They are largely confined to aero and marine transportation. However, the growing presence of GPS alters the field of electronic aids and increasingly all forms of transportation including that of pedestrians. Railway signalling includes an increasing area of electronic aids; road forms generally lack electronic aids though not electronics. Electronic indicators can be divided into five segments: final approach aids, radio-beacons and en-route short-distance aids; hyperbolic aids; satellite navigation; radar aids. The first segment combines the oldest form of marine navigation with a range.

The oldest extant aid is the Radiobeacon; it dates back to the 1920s. It is a radio transmitter that acts as a single station producing a single message configuration. (US Hydrographic Office, *American Practical Navigator* (Bowditch) 1966, 942). Potentially any A-M radio station could serve as a Radiobeacon (or NDB). (Clausing 1987, 78). Ships required equipment to receive the indications. Many of the installations were omnidirectional; some directional forms were also in use. (*International Marine A/N* 2010, 191; *International Aero, T-M* 1994, 151-152).

Radar is a significant element in navigation. However,

direct safety aids usage is a small entity. This is especially true for marine aids. A radar system includes a transmitter that generates radio waves (termed radar signals) in specific directions. Signals are reflected (and scattered) in multiple directions. Radar receivers detect shape and location of objects through reception of interaction of transmitter signal and contacted objects. The working of radar is a backdrop for radar safety aids. (Radar. Wikipedia).

Three forms of radar safety aids are in use: ramarks, racon and radar reflectors. Ramarks are a type of primary radar while racon is a secondary form. Radar reflectors are passive. Ramark does not require ignition by shipboard radar systems. It broadcasts continuously and emits omnidirectional transmissions. Racon needs to be triggered before a message emission is transmitted. Radar reflectors provide enhanced radar reflective quality. They are a basic feature for many buoys. Some land-based reflectors are in use. (USCG light list publications, 1962-1997; IDAMN 1970 Ch 4; *International Marine A/N*, 2010, 193-194).

Hyperbolic navigation systems once constituted the largest part of radio aids. They extended back to World War II and developed into a variety of approaches. The word hyperbolic comes from the geometric term “hyperbola” which refers to the curved line of that shape. The system creates hyperbolic lines of position (LOP) by measuring the arrival of signals from at least two integrated transmitters at different locations. A ship or aircraft with receiver calculates the difference of the arrival of signals. With a third transmitter the position of the vehicle can be determined.

The various systems produced radio signals at different frequencies. Some emitted pulses while others favored continuous waves. Some measured differences in phases rather than in time. Many systems employed a master-slave pattern. Omega, a newer system, employed a few stations globally and did not follow that pattern. Signals from any two stations produced the needed data. Loran-C was the primary system before Omega. Other forms of Loran were employed as well as other systems including Decca. (Peterson and Hartnett, Access Science 2008 provides a source for basic information; *International Marine A/N*, 2010, 186-190).

Satellite Navigation is approaching a place of dominance for many forms of transportation. Older navigation systems are being phased out in favor of Global Positioning System. GPS may represent a different approach yet it too is based on transmitting radio signals. Two dozen satellites circumnavigate the planet twice daily and supply needed information. Specialized receivers are required for gathering and utilizing the data. The GPS role as indicator produces continuous information which, nonetheless, constitutes messages and meanings. It is the most complex and sophisticated message producing system while it is among the smallest physically though the largest purveyor of messages. Additional sources provide further discussion of GPS workings. (Garmin 2011, *International Marine A/Ns*. 2010, 185-186).

Kayton 1990 speaks of safety aids as having two dimensions: guidance and navigation. Guidance provides direction to destination. Navigation provides more precise destination information. They display similarities. (Kayton 1990, 1-3).

Instrument Landing Systems (ILS) has three units: Localizer, Glide Slope and Marker Beacons. The Localizer produces signals creating azimuth guidance on 109-112 MHz frequency. The airborne receiver that receives information symbols denotes relation of plane to approach runway. The Glide Slope (frequency between 328.6 and 335.4 MHz). The message information refers to altitude; onboard receivers accepts messages and determines their meaning. The final element consists of Marker Beacons. They transmit messages known as “decision height points.” (*International Aero. T-M* 1994, Ch 37. This is also the reference for remaining topics).

Microwave Landing System broadcasts (MLS) on 5 GHz frequency which is SHF rather than the VHF of ILS. Localizer and glide slope together create one approach path at a fixed angle of descent. Aircraft receivers accept data that translates into message and meaning. The third component, Precision Distance Measuring Equipment, provides data regarding on-going distance information.

Remaining aero aids can be viewed as an en-route short-distance aids. VOR (VHF Omnidirectional Range) is a long-enduring aid essential to navigation though less so in the present. It transmits messages of two forms: non-directional and omni-directional. Aircraft receive information that results in bearing information.

Distance Measuring Equipment (DME) includes a ground based transponder and the aircraft equipment which is both transmitter and receiver. Airborne equipment transmits a pulse signal to the transponder which in turn transmits a signal that can be identified by the interrogator. Distance infor-

mation is determined by the messages received.

TACAN is a primarily military system that includes VOR and DME functions while VORTAC brings together both civil and military electronic systems.

Some railways employ a form of radio aid. It goes under several names including Radio Token. An older system employed physical tokens that admitted a train to a track section. The radio token has a similar role but it has eliminated the physical object by the sending and receiving of radio signals. (*T-M Database Railway 2009*, 391).

2B2 Messages & Meanings

a) Introduction

Unchanging Messages and Meanings present a complex panorama. Contrivances and their production of messages includes tree branches, 24/7 high intensity lamps, pavement markings, satellites, bells, traffic cones and many more devices historic and new, passive and active. What they share are a means for producing a single message. A message that can range from simple in the extreme to markedly complex.

All modes of transportation include unchanging forms. Though they are less represented by rail activities. That mode is largely dominated by signals which control train movements. Signs and markers supplement signals. A limited use of explosive has been employed by some rail systems. Road transportation has a more significant level of unchanging forms. These include signs, markers, and markings that repre-

sent a vast assemblage of forms and messages. A limited usage of lighted beacons (with an unchanging message) is also included.

Aero and marine modes are substantially marked by unchanging messages. Signals with changing messages are present but only to a limited degree. Aero operations include fully-lighted types but more often lights are employed for night usage. Surface markings and signs are also in use. Electronic forms include messages that can be of a unitary nature but also forms that provide single yet individual messages. Other forms have a multi-faceted character.

Marine transportation includes few signs and, of course, no surface markings. Buoys and fixed structures constitute many of the devices. They can be unlighted or lighted with a day dimension. Satellite navigation is increasingly important. Structures, whether traditional lighthouses or simple daybeacons, can be of long-enduring character. Coherence is found through buoyage and beaconage systems and rules of the road.

Coverage of indicators, messages and meanings will follow the pattern of 2B1: Visual devices are divided into fully-lighted, partially-lighted and unlighted. This is accompanied by acoustic and electronic segments. To some degree modes are considered within those segments.

b) Messages & Meanings

1) Visual

(a) Fully-Lighted Devices

Many of these devices that have unchanged messages/ single messages are aero nav aids. Aero Final Approach devices are a complex system of different systems both obsolete and current. Some are based on lights only while others include patterns and alignments. The use of lights varies greatly since there are differences in light colors and in the number of equipment boxes for a given installation. Messages can be simply summed up: the key concern of a flight crew is to descend to the runway at the correct descent approach level. The messages and meaning indicate whether a given plane is at the correct level, or above or below that level. The various indications forms given a similar message and meaning (*International Aero T-M*, 1994; *T-M DB: Aero, Nav*, 2009).

Two aero systems among many are Visual Approach Slope Indicator (VASI), an obsolete system, and Precision Approach Path Indicator (PAPI), a current system. Basic VASI consists of two units. When on target white light is seen in the upper unit and red in the lower. Above position will display two white lights; if below two red lights appear. PAPI has a single box which also displays red and white messages. If on approach two white and two red messages appear. Slightly low indicates three whites and one red. Far under position will generate four red, and well above position displays four whites. (*T-M DB: Aero Nav Aids* 2009, 153, 156; see also *International Aero T-M*, 1994).

Approach lighting systems are both simple and complex in nature. Simple because the message configuration

consists of primary lights that are steady-burning in medium or high intensity in white. Systems requiring additional lights add steady-burning red lights. Appropriate flashing white lights are added as needed. The messages and meaning present a simple one of laying out a clear path to approaching runways. (*International Aero. T-M*, 1994, 85-91). The complexity is generated by a choice of several categories of navigation. Variable intensities of light also increase options and complexity.

Limited fully-lighted forms with unchanging messages are found in road and marine navigation. US employs lighting device forms as part of road forms. These lights are of several types including fully-lighted as well as night hours only. They delineate hazard areas. (USDOT *MUTCD* 2003).

A limited range of fully-light marine aids are in use. These include marine traffic lights of high intensity capability and Leading Lights. They employ sealed beam lamps. Port traffic signals utilize lanterns capable of day as well night usage; IALA has an alternate title of Port Signals. Major lighthouses can be equipped with high intensity beacons for day as well night usage. These units use quartz lamps of high intensity. (Pharo Marine ca 1991).

(b) Partially-Lighted Devices

Marine Lighted Markings do not have the controlled message indications familiar to road and rail systems. Neither do they have the narrow range of steady-burning and flashing indications of aero aids. Instead, marine forms employ a wide range of light phase characteristics ranging from fixed

(non-blinking) to ultra quick flashing characteristics. More than 20 characteristics are in existence though often only a limited range are employed. For example, the IALA system (and national systems in conformity) has specific characteristics for specific functions (e.g. Group Flashing for Isolated Danger Marks and Quick or Very Quick for East Cardinal Marks) which involves about a half-dozen characteristics. (IALA Buoyage Conference Report, 1980). Each marine light has a “signature” characteristic. For example, a flashing characteristic can take many forms. It can include a 2 second flash and 8 seconds of dark in a period or a 4 second flash and 10 seconds of dark among many permutations. (*T-M DB: Marine* 2007).

There are two “ingredients” for fixed marine lights: The light apparatus and its characteristics, and the day message. Major lights (lighthouses) include a tower that serves as a daymark while minor lights often include a formal daymark attached to the structure. Discussion of buoyage and beaconage systems will include formal daymarks. Many towers are painted and frequently in white. Some towers are painted red. Lantern houses may be a different color than from the tower. A diverse group of stripes, bands, checks and diamond have been added to increase clear identification of the tower. Towers can also be altered by painted graphics. (*International Marine A/N*, 2010, 144-145).

Aero obstruction lighting can be both partially-lighted as well as fully-lighted. Message are made up of lights that are steady-burning red lamps, flashing red lamps or flashing white lamps. The meaning of the device remains the same: that of a warning to stay clear of such marked structures. Day

markings, when present, can be a dimension of warning messages (*International Aero. T-M*, 1994, 115-119); see also *T-M DB: Aero* 2009.

Beacons for airports/aerodromes emit a message of white or white/green for land airports, and white or white/yellow for water airports. The light flashes or rotates. The meaning is a simple one of identifying the proximity of an airport. Identification (code) beacons display a green message at land airports and yellow at water airports. The old code beacon has an obstruction version known as a hazard beacon (*International Aero. T-M* 1994, 118; *T-M DB: Aero* 2009).

Taxiway and Runway lighting manifests a complex appearance. Yet there is a clear pattern of lights, position and significance. Lights delineate boundaries of taxiways and runways. In some instances centerline are also lighted. Intersections and special requirements for aircraft can also be marked. Segments of pavement may also need delineation (ends of pavement, main sectors among others). White lamps dominate for runways. Traditionally blue lamps denoted taxiways. Green lamps are now employed for taxiway centerlines. Red lamps indicate thresholds, wrong direction and other situations requiring warnings. Meanings of the message indicate the landing areas and provide information on safe navigation (*International Aero. T-M* 1994, 107-110; *T-M DB: Aero* 2009).

(c) Unlighted Devices

i) Signs

The most extensive sign system is found with roads. It requires a three-part survey of warning, informative and regulatory signs.

Warning Sign of UN 1968 included two models: The European model and the American model. The former is an equilateral triangle with a ground of white or yellow with red border. The second is diamond-shaped. It has a yellow ground with black rim. Messages and meanings are framed within the models. Basic types of signs employing the models include Roadway Alignments (e.g. dangerous turns signs which takes several forms), intermittent moving hazards (e.g. pedestrian signs, animal crossing), and intersection signs. (*International TCD* 2004, 108; UN 1969 CORSS 109; US MUTCD 2003, 2A).

Informative Signs appears under several terms (Guide Signs is employed in the US). These signs are very diverse and lack the more cohesive signs of warning signs. Informative signs are often rectangular in shape. UN 1968 speaks of white or "light-coloured" symbols with a dark ground. US employs a green ground with white symbols for a broad variety of guide signs. Major forms include distance and direction signs, route markers, mile posts, signs of general interest. Route markers and mile post are possibly part of markers as well (*International TCD*; 2004, 118; UN 1969 CORSS 91, 120-121).

Regulatory signs for UN 1968 are circular with white or yellow ground, black symbols, and red border for prohibitive and restrictive signs. Oblique bars are red. Priority signs are diamond-shaped with black rim, white bars and yellow or

orange center. Mandatory signs are circular with blue ground and symbols in white or light color. Standing and parking signs are circular with blue ground, red border and red oblique bars. IAIMM 1967 employed round plates with white ground with black symbols and red border. Red oblique bars are added when needed. US MUTCD generally used rectangular-shaped plates with emphasis on vertical dimension displaying white grounds and black symbols and rim (*International TCD* 2004 143-147).

Aero signs include mandatory instruction forms that include taxiway runway intersections, holding signs, and no entry forms. The signs display a red ground with white symbols. Specific signs names indicate the meaning of the message. A second major group are information signs. Such signs display black messages on a yellow ground. The reverse pattern is approved. Many of these signs are of a “catch-all” character (*International Aero. T-M* 1994, 123-124).

ii) Marks, Markers, Markings

These terms are basic to Transportation and T-M yet definitions are elusive and can overlap. Markings constitutes a general term though it can have specific meanings. For road forms it is both specific and general. It encompasses pavement markings, object markers (which are within object markings) and specialized forms (e.g. delineators and barricades and channelizing devices). Markings often lack alphanumeric symbols. Any symbols may be brief. Graphic markings are a common occurrence and they frequently occupy the full space of the physical object. This contrasts

with sign symbols which are present on a sign board but do not encompass the object. Mark is a common usage in marine usage especially by IALA. It often refers to unlighted beacons and/or buoys and may pertain to some forms of radio aids; this is also true for aero forms. (IALA 1980, BCR).

Markings or surface markings are often employed for road uses. White and yellow colors are often employed. Markings often denote boundaries for the use of transportation modes. Low level retroreflective markers are frequently part of surface forms.

Railway markings are often localized or at most are regional. Some general remarks can be made. Pillars and posts are one basic form. Many are white which may be combined with black, yellow or red. They denote boundaries, railway crossings or give km distances. A smaller version, petites, are often black or white with bands or stripes. They provide information that the signal cannot transmit. Messages and meanings include noting track junctures and giving advance notice of signals. Boards are frequently employed for incremental warning of upcoming signals. Boards can be approximately the size of planks. Geometric designs include diagonal stripes, chevron and lines. They are employed and frequently in black on white ground color schema. Large boards resembling signs are employed in some systems. Black on white patterns are used for halt or stop boards. Sign messages are absent. (*International Railway Signals*, 77, 194-197).

Road forms include object markers, delineators, barricades and channelizing devices. Object markers often consist

of reflective objects grouped together. These forms are often yellow and provide warning of objects in or near the roadway or the end of a roadway. Delineators are small reflective objects on stakes delineating the end of pavement. Cones, tubular markers, drums, and barricades are short-term forms denoting caution or danger areas. White and or orange marking colors are frequently used. (*T-M Database: TCD 2008; International TCD 2004*).

iii) Structures

Daybeacons have had a long history with some individual daybeacon forms serving for a long span of time (e.g. tree branches). Older forms were generally of distinctive design so that the structure itself conveyed the message and corresponding meaning. These forms included recognition beacons, leading marks, obstruction markings, channel markers. That is substantially their contemporary role though perhaps without recognition forms. A variety of groups were responsible for the beacons including national administration. Those responsible may have at time added color or pointers. Earlier buoyage systems largely omitted fixed beacons. (*International Marine A/N 2010 and a primary source: Naish 1985*).

IALA is the first system to include beacons (and in fact all non-major aids) as a full participant in a system. Regional rules within IALA (e.g. green to starboard in region “A” and red to starboard in “B”) applied to beacons as well as buoys. The IALA system includes topmarks (small geometric shaped objects) both for buoys and beacons (IALA BCR 1980). The messages were enhanced by Topmarks. In

North America topmarks are in use (though not a major feature in the US for fixed aids). However, dayboards serving as daymarks are a major feature though not employed in IALA practice. Daymarks are in the shape of geometric forms include triangles and squares. The colors and other symbols are determined by an aids to navigation system (*International Marine A/N*, 2010, 165-167; Canada 1975, 2011). Colors, shapes and other features are similar for lighted beacons and for buoys. IALA includes aids and messages for lateral situations and also for isolated dangers, safewater navigation and new dangers. (IALA BCR 1980).

Aero markings are large surface marking systems that employ the color white. There are two principal groups: runway-related functions and taxiway-related functions. Their function is analogous to those of road surface markings. (ICAO 1990, 36-46).

Many aero markers have the form of edge markers. Unpaved runway edge markers displayed a flat rectangular shape; they mark serviceable areas. Stopway Edge markers have the shape of a vertical board. Taxiway edge markers are retroreflective objects displaying blue and Taxiway center-line markers are retroreflective objects in a green hue. Unpaved taxiway edge markers are of a conical shape and above the surface level. They also have a boundary role. Boundary markers are triangular shaped objects of a low-level design. (ICAO 1990, 85, *International Aero. T-M*, 1994, 129-134).

Other marker forms include wind cones and wind tees (ICAO employs the terms of landing director and wind indicators). These indicators are partially lighted. (ICAO

1999, 41; *International Aero T-M*, 1994, 179).

Obstruction markings consist largely of painted objects patterned according to guidelines. Colors are of orange and white hues. (FAA 1991, 7).

Railway signs are diverse in types and messages. Many signs are part of national systems though some are regional in character. Signs often display black letters on a white ground. Rectangular and vertical shape are relatively common. Many sign systems are concerned with similar issues: tracks, junctions, stations, yards, political boundaries, geographical features. Speed signs are of greater concern in Europe than North America. Such signs are a major part of European signage. Section and block signs are of major significance for many systems. A system of electric traction signs is shared by many European railways. Terminology is often confusing. A variety of terms (e.g. indicators, plates, markers) are apparent synonyms for signs. (*International Railway Signals*. 1991, 46, 76).

(2) Acoustic Devices

Most acoustic aids that generate unchanging messages are marine in nature. There is also a small category of detonators employed in some railways (e.g. UK) that serve as a form of fog signals. This is a declining form though the diversity of now defunct forms retain use in communication and semiotics studies. (B & M 1981, 43; Hollingsworth 1983, 41-42; RONT 2008).

Sound messages have two elements: Character of the sound wave produced (e.g. sound of bell, gong, siren) and the signal period. Signal period includes the length of each blast as well as the length of silence for one period or transmission. Periods of operation may constitute a third element. Some signals operated continuously during the year (when fog or other conditions were present). (*International Marine A/N* 2010, 7-1). Some signals operated during the periods of fog while others operated seasonally. USCG in the 1970s established six characteristics for fog signals. This limited range may have been deemed sufficient since many for signal forms were phased out while diaphragm horns were increasing usage. Buoys had two characteristics in addition to random operation. (USCG 1979, 7-1).

A variety of messages are employed for railway detonators depending on different systems. A sample of messages can include one for stop and two for caution. Three can mean stop until proceed authorizatio. One exploding device can mean stop; two indicate caution. (*T-M DB: Railway Signals* 2009, 380).

(3) Electronic Devices

Messages for electronic aids are of three types: 1) single units that provide an unvarying message; 2) single unit with an individualized message; 3) single unit with a single message, or rather a series of messages focussed on one meaning.

Radiobeacons/Nondirectional Beacons, VOR and other single station units emit one message. A vessel receives the

message in relation to a fixed point of transmission. It aids in determining location but does not provide an exact position. Some units provide bearing information while others add distance data as well (*International Marine A/N*, 2010, 191-192; *International Aero. T-M* 1994, 151).

Hyperbolic Navigation and Satellite Navigation provide data that can be received and interpreted so that the position of the receiving unit can be determined. Every message is individualized since it refers to the given position of a vessel at a precise moment. (*International Marine A/Ns* 2010, 185-190; *TM-DB Aero* 2010; 457-65, 366-69).

ILS, and MLS guidance aids provide information when approaching an airport. The several components of the systems provide information on altitude, relation of plane to upcoming runway, and descent height provides a “package” of messages results in a multifaceted meaning. (*International Aero. T-M*. 1994, 185-190).

2C Changing Messages/Multiple Messages

2C1 Indicators

a) Overview

Indicators for this category are largely from road and rail T-M forms. A limited range of indicators from aero and marine forms are in use. Many of these forms have an enclosed housing for the apparatus. In essence these housings are similar though there are many permutations in use. A range of predictable elements are found within the housing.

The shaping of messages can be found in the individual unit though electronic and mechanical equipment linked together by cables are a commonplace. Details are not possible in this coverage since diverse forms are global in scope. However, enough information can be supplied to explain how a message is generated and transmitted.

Indicators are often visual and of a fully-lighted character; there are some partially-lighted and unlighted forms of varying designs. One type is the semaphore in which separate day and night phases are linked together; other forms are integrated without linkage. Some signal forms literally move. They do not literally change positions horizontally though the message apparatus can revolve; a variant form can include a stationary assemblage in which the T-M aspect moves. There are also forms lacking a night portion. Other forms can be lighted/and or unlighted. Acoustic and electronic T-Ms are infrequent and even rare in this category.

Messages and their meanings are not a fully separate topic from the physical dimension. These various aspects can be very much interwoven and integrated. A discussion of the physical must not overlook the physical devices that exist to create, generate, transmit a series of characters of diverse natures and construction ending in a meaning that requires a response from the receiving agent.

b) Fully-Lighted Devices

Messages and meanings may manifest endless forms in the abstract. However, in a specific setting messages and meaning may be restricted to a narrow range of possibilities.

A brief coverage can often portray colors, possibly graphic forms, arrangement of the colors, but the physical background may be much more complex and the information on the inner workings can vary greatly. Brief explanations can be succinct though they become superficial.

The primary forms of full-lighted devices can be traced to road signals and rail signals. Road signals are short range in intensity since signals are repeated from intersection to intersection. Signal forms are composed of a housing, lamp socket, reflectors and a relatively simple lens. Signals may take various configurations yet the basic workings are similar. Housing arrangements are frequently horizontal and often have three physical units. The housing can be vertical in some instances. Additional functions require units beyond the basic level. A recent and widespread change has been the use of LED “bulbs” instead of incandescent bulbs.

Railway signals require longer distance equipment than road signals. Double lenses are a common place feature since greater candlepower is necessary. Reflectors are less a feature of rail devices than the shorter range road devices. The number of lenses and size, shape, and arrangement can vary greatly from system to system. Vertical straight-line housings are a common feature though other forms are in use. Some national systems employ a kind of free form arrangement with multiple lamps. A special form is the searchlight signal that contains three colors with one housing. An electro-mechanical device positions the correct color as programmed. The searchlight signal is declining in use while newer forms of color-light increase.

Some road signals are free-standing units. These models include a control system that programs the correct order of lights and duration of signals. More often a centralized control oversees an integrated system of signals. This is often the case with rail signals but also with road forms.

All-lighted signals display a fixed unvarying image. The images (or aspects) “take turns” as programming dictates. Special messages including graphic symbols are present in both road and rail service.

c) Partially-Lighted & Unlighted Devices

Many CMM forms are partially-lighted while some forms are unlighted. Many examples of these forms refer only to railway situations. The topic can be examined without actual reference to the mode yet concrete usage incorporates it. A principal type of this form was the semaphore signal; it is now largely archaic. Many semaphore messages are replicated by the more contemporary all-lighted signal. The variety of signals illustrates the ability to display images by the use of diverse designs and technology. The semaphore signal form has had a variety of permutations. The most essential difference among the forms is the way that the signal arm (also known as a blade) and the necessary light projections were configured. UK and US forms affixed the lenses to the inner end of the blade thereby allowing for a position pattern that kept day and night parts in alignment. A second major form separated arms and lenses and lamps; the position of the arm matches the position of the correct lamp but remained separate. Lamps often burned petroleum-based product in older signals. Electric lamps eventually dominated.

Semaphore signals displayed movable signals though the mast and related parts remained stationary. That was not the case with many forms of low-level signals at switches and other railway appurtenances. Many of these signals (known as switch lamps and ground discs among other terms) literally rotated. Movement was dictated by the position of a switch regulating train movements on interacting tracks. The signals contained both day and night dimensions. Older versions included a petroleum-based lamp, and reflectors; new versions employ electric lamps and lenses. Both versions were contained in metal housings. They were of low-power since long-range viewing distance was not needed. Messages were often a basic nature with the equivalent of yes/no transmissions.

Some of these signals included a target that revolved but whose lamp remained stationary in contrast to forms that revolved in their entirety. Several nations, including the US, employed unlighted signals termed targets. The targets of diverse designs were attached to a mast that was in turn attached to a switch mechanism. Switch lamps could be added thereby creating a partially-lighted form. Switch lamps could be installed as night-only forms as well.

One other form of partially-lighted signal is the Board Signal (also referred to as Signal Board in these studies). This form of signal displayed boards of various geometric shapes. Some forms revolved on a pivot while others were hinged. These forms frequently were of a single dimension so that the second position of the signal displayed only the edge of the board. The second message was of a passive character.

Even if many railway signal forms have become obsolete they remain very much part of the spectrum of safety devices for modes of transportation. They are a timeless communication system displaying information of messages and meanings.

References for this segment are found in previous T-M studies including references in those works.

2C2 Messages & Meanings

a) Introduction

Most CMM are found in road and rail forms. There are limited forms for aero aids and infrequent marine forms. Road signals include numerous signals though they represent a relatively narrow range of messages and meanings. Rail signals, by contrast, include diverse forms. Because of those diverse forms rail signals require more attention than road forms. There remains an essential core for all CMM forms: ongoing indications denote when a vehicle can either begin or continue operations, proceed at a slower pace, or cease operations. The primary focus in this study will center on core messages and meanings. This study remains linked to modal and database monographs which include more encompassing information.

Messages are the symbolic characters generated by indicators. For CMMM these characters are often pre-programmed and frequently set within a systems approach.

Meanings are then ascribed to those messages. It would be an easier task if messages were described separately. Yet it remains important to place the closely related processes together even though that generates a more complex procedure. Road signals consistently display color messages accompanied by some graphic symbols within a range of patterns. Rail signals display a wide range of messages and meanings through diverse systems of images: color, position, color-position, semaphores, signal boards.

An earlier draft of the table of contents assigned messages to communication and information and meanings were assigned to semiotics. While that might have been convenient it would also have been rather simplistic and have created an illusion of accuracy. Messages and meanings need to be in close proximity with some attention to separate understandings of messages and meanings and also to relationships among communication, information and semiotics/semiology.

b) Meanings Before Messages?

A perhaps odd observation can be made about some versions of railway signals; more precisely about specific presentations of signal codes. In those codes one can begin with the meaning and only then proceed to the messages. That interpretation may violate a communication/information/semiotic rule since one is supposedly to start with messages and then determine the meaning. Nonetheless, starting with meaning it becomes easy to attach messages and the indicators that generate and transmits the messages.

If one does speak of messages followed by meaning a

problem can be encountered since a message (e.g. proceed) coming from a less than fully color light signal (e.g. a signal board) is at odds with the former message configurations. Yet the meaning is the same. By starting with messages different forms of devices are split asunder. But if one begins with meanings then there is no problem since meanings are together and different kinds of messages are found within the meaning matrix. This anomaly can be seen in a comparison of charts of railway signal codes from Canadian National railways and that of AAR (US). CNR displays one signal form (searchlight signals) and the chart begins with messages and proceeds to meanings. But the AAR displays multiple types of signals and the chart presents the reverse pattern: meaning then message forms. Both charts present coherent information (CNR 1961, AAR 1956).

c) Messages and Meanings

Messages and meanings for CMM are placed within that context. Three colors, Green/Yellow/Red have an especially significant role for this form of message and the accompanying meaning. The color usage is global in scope. The basic colors can be employed as a simple, vertical pattern. That is often the case with road signals which generally manifest a large simple and basic use of colors. Rail signals can be more complex. That statement is true both of indicators and the variety of message producing elements.

The basic complexity is augmented by color combinations employed in railway signaling. Multiple colors supplement the basic level of aspects and indications. In combination colors the first hue is more important in determining the

direction of the message/meaning than the second. Reversing the order of colors increases the restrictive character. Green/yellow (GY), the most common combination, exemplifies that principle. The message refers to some level of reduced speed or medium speed category but it favors a proceed indication. Y/G would be more restrictive. Meanings in multiple colors varies notably between systems. Other moderately common forms include Yellow/Red (YR) and Green/Red (GR). Reversing the order of those combinations also increases the level of restriction. (*International Railway Signals* 1991, 113-116).

A variety of additional colors are also employed. These secondary colors can be employed to distinguish main-line signals from points/switch indicators. White, purple, blue are employed among other colors. Secondary colors may be “teamed” with a basic color. Position and color position also utilize colors other than the basic range. Messages may be at variance with primary uses yet meanings can be similar. (*International Railway Signals* 1991, 116ff).

Signal colors and meanings can be similar for a variety of systems. However, frequently there are differences which range from slight to significant. A presentation of difference and similarity can be seen in two major entities: the North American practices of Canada and the US, and the work of International Union of Railways. The latter group represents many European railways as well as systems elsewhere. It does not represent a functioning signal system. But it has provided basic principles that can be employed. The principles together offer a substantial insight into color messages.

These include:

Green light denotes track section is clear beyond the signal.

Yellow is frequently regarded as a cautionary signal. However, IUR describes a yellow indication in different terms: it is a “warning to stop”

Red, the third principle, has a simple message: “stop,”

The fourth principle is that of the permissive stop. A sign denotes stop signals with that function.

Some systems employ a speed signal system. That of IUR has four speeds and displays “luminous aspects (lights or symbols).” (UIC Principles ... 1961).

Canada and the US present a complex code of aspects (the appearance of signal lenses) and indications (the meaning or signification). The code includes both basic forms and a more nuanced version. The code is based on lights and arrangement of lights. The US version includes all forms of signals including partially-lighted forms. Railways of both nations belong to AAR and there are similarities in the respective signal codes. Signal messages and meanings have three segments: aspect (appearance of the signal), name of signal, indication (meaning). A Canadian National chart begins with aspects followed by indication and name. AAR begins with meaning and proceeds with the other two forms of information. A proceed indication has the name of clear signal. A caution signal (yellow) known as an approach signal gives the instruction to proceed, prepare to stop at next signal; the indication includes further instructions. Only proceed and stop include simple one-word meanings. (AAR 1956, CNR).

Messages and meanings for road signals are more simple in design. Three colors are in use: green, red, amber or yellow. Amber can be viewed as a “less-saturated” form of yellow; in rail uses it is within the “restricted signal yellow.” (Bailey, Colin, *International Railway Signals* 1991, 116). Yellow is listed in some sources. Green denotes proceed; red indicates do not proceed. Yellow or amber indicates a red message is to appear shortly. Messages are presented in circular lenses that are vertical or horizontal in arrangement. Graphic signals and pedestrian signals can be at variance with the basic indications yet the essential three-message matrix with accompanying meaning is in place. (see T-M Studies).

ABBREVIATIONS

AAR	Association of American Railways
ADB	Corporation Name
AREA	American Railway Engineering Association
B & M	Brignano, M. & McCullough, M.
CAA 1942	Civil Aeronautical Administration
Canada	Entries prefaced by entries
CNR	Canadian National Railways
FAA	All entries begin with FAA, Federal Aviation Administration
H & P	Hughey & Phillips
IALA BCR	International Association of Lighthouse Authorities prefaced by acronym; BCR, Buoyage Conference Report
<i>IAMM</i> 1967	Pan American Highway Congress, <i>Interamerican Manual</i>

ICAO	International Civil Aeronautics Organization. All entries begin with ICAO
<i>IDAMN</i> 1970	<i>International Dictionary of Aids to Navigation</i> . SEE: IALA
RONT	MDA Railway Object Name Thesaurus
S & R	Schement & Ruben
United Nations	United Nations Conference on Traffic
US MUTCD 2003	US DOT FHA <i>Manual on Uniform Traffic Control Devices</i> editions. Alternates: US MUTCD, US DOT MUTCD, US TCD Handbook
USCG	US Coast Guard entries begin with USCG
UIC	Union Internationale des Chemins de fer.

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