T-M

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

Brian Clearman

Mount Angel Abbey

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An Integrative Systems

Perspective: Communication,

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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 which brings together the various modes and resulting safety aids rather than dealing with separate entities. The idea remained in a moribund state (or in a germinating state) for quite 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 curious it also summed up the idea of the projected monograph.

This final monograph will focus exclusively on the integrative character of T-M forms. This is in contrast to most of the T-M studies since 1998 which have continued to focus on to individual forms within a transportation mode. Even the composite study in the Database sub-divided the information by modes. While there are limited integrative materials in the Series they are often provided tools for the examination of form-focussed descriptions. This study presents T-M forms as an unified discipline. While it may tend toward an abstract construct it generally maintains a concrete perspective.

Several alternate titles 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 which can include T-M yet it is

unlikely the term has been so employed.. Communication has multiple meanings. It often refers to direct human communication and telecommunication. Communication science, theory and technologies are specific dimensions of the 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 understanding is the original and current name of the T-M Series.

An early work that has influenced T-M was *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 the work away from a nearly exclusive focus on theory of communication. However, the Series that included Cherry's work (termed "Studies in Communication") also included semiotic, language and linguistics titles. The title of that Series quite possibly was the source of T-M: A Study in Communication Monograph Series. 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.

Finally, semiotics/semiology has a significant role in the study but that was omitted from alternative titles. A more recent examination of communication and semiotics will reveal points of commonality but also a notable difference in perspective. And perhaps less of a blurring of boundaries than can be found in the older Studies in Communication. The term System remains a key term even

when other changes are made in the several title concepts.

Further reflections on the theme, content and title for the study have led to a greatly revamped 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 revamped 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 provide 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 version divides the studies into integrative, modal and database segments. This integrative 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*
- History
  - 1 edition, 2002
- T-M: An Integrative Perspective: Communication, Information, Semiotics**

Modal Studies

- Marine Aids to Navigation*
  - 3 editions, 1981, 1988, 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
- Aeronautical
  - 2 editions, 2001, 2009
- Road
  - 2 editions, 1998, 2008
- Railway
  - 2 editions, 2000, 2009
- Composite**
  - 1 edition, 2006

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

**Three studies are projected: This edition of T-M: An Integrative Systems Perspective: Communication, Information, Semiotics; The 8th edition of General Table of Contents; And the 2nd edition of Database Studies: Composite Categories Classification & Index.

CHAPTER ONE

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

1A Basic Terminology

1A1 Communication/Information/Semiotics

a) Introduction

1) The Study

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 proces of analysis of messages and their meanings. Terminology is the primary content of the chapter. The first segment focusses on three overlaping processes: communication, information, semiotics. Semiotics/Seminology 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, 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.

2) Chapter 2

Terminology for this study takes several forms. Systems (1A2) serves as an overarching term in conjunction with Transportation-Markings. 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 overlapping or 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 perform. For that reason they are brought together in the staff in a way that can illustrate linkages between them as well as indicate separate identities. The confusion surrounding 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 idea of communication is to be found in Berelson & Steiner 1964: "Communication: the transmission of information, idea, emotion, skills, etc. by the use of symbols ... it is the act or process of transmission that is usually called communication." (in Schement & Ruben 1993, 25).

"Act or process" adds clarity to the core term of transmission and symbols clarifies the nature of information in transmission. Danesi's definitions of communication includes the "production and exchange of messages by means of signals, facial expressions, talk, gesture, or writing ... ." (Danesi 2000, 58). Production is an important element since messages or units of symbols have to be produced or generated in order for a transmission to be undertaken. A major focus in this study is the use of the term Indicator. Indicators are technical devices (though that can be very muted for some T-M forms) that generate messages which are transmitted. In this study brief explanations of how the device works will be included. It is important to add the concrete level of operations to what can easily become an abstract explanation.

Information definitions are also diverse. In part because specialists in very different fields of study produce explanations within their respective context. 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 machines." He defines information in a context of information theory or computer science in a more technical perspective: " [the] ... precise measure of the information or content 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 meaning dimension.

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 what perspective is employed 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 nonetheles 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 represent an intriguing notion that the entire entity could be a larger and 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 purposes and interaction.

It is quite 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 provides a variant perspective that enriches an understanding of messages and meanings. Even extensive coverage of messages and meanings can bypass 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, 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 is more common in North America (Berger 1984, 91). Thomas Sebeok aided its popularization. (*T-M Foundations* 2008, 57-58).

Definitions displays diversity with sign or sign system as a 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). 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 Systems is a more important term in this study than sign.

Sign is a core term for the discipline. It is more of a mental construct than a physical element. The complete sign assembly can be seen as including the sign vehicle and the sign process with its signification. Sebeok viewed the latter element as the meaning of the message; that is, sign. (Hérvey 1982, 47-48).

At the heart of semiotics/semiology is the idea of

semiosis. The coverage of that topic is a reprint from *Foundations*:

> Semiosis is concerned with sign process. Sless offers a succinct definition: "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. Hérvey has examined variant formulations in Morris and there are seemingly five components in his schema (Hérvey 1982, 47-48).
>
> In employing the ideas of Morris one can see these elements in semiosis: The sign (a mental construct rather than a physical object) stands for something else (the object. The message of the sign leads to an interpretant (Nöth 1990, 50, Sless 1986, 9). The interpretant creates a disposition in the interpreter to act in a given way to the sign. The signification of the sign is the meaning that it has in this process. For example, 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 the sign; it stands for the side of the channel, and the interpretant is that disposition to keep the edge of the channel to the right of the vessel. The signification or meaning of buoy (sign): 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).
>
> A second example would be 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 disposition for a train crew (the interpreter) to proceed through that section of track at the agreed upon maximum speed. The signification or meaning of green is that the track is free of obstructions." (*Foundations* 2008, 41-42).

One additional component can be added to semiosis: the context of the sign. For Morris context is the "whole situation in which the sign occurs." (Morris in Hérvey 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. Code and Sign System can be viewed as synonyms. The terms 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). For a crew of a transportation mode it can be said that every T-M form represents a interrelated safety component on a journey even in singular operations.

1A2 Indicators & Other Terms

a) Indicators

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

Transmission of messages requires a generating and manufacturing source for the messages to be transmitted. Generating sources can encompass diverse means including radio transmitters, computers, signal lamps. 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 limited and of a general nature.

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 with deeply embedded images. Those terms also encompass far more than a generating source. A possible term is that of Indicator. It can suggest Indication (employed in some signal forms for the message and its meaning) but with less established images. Indicator may suggest existing elements within a transportation mode but it can be expanded to suggest elements outside such a mode.

The term indicator appears in railway signalling. It is employed 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). They also include various kinds of trackside indicators as well as route and junction indicators. T-M studies of railway signals provides details.

To borrow the term 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 reviews a wide range of indicator apparatus. Non-moving safety aids such as signs and surface markings are also included though they are of a more restricted and passive nature.

A Transportation-Marking can be defined as an indicator that denotes the validity of accessibility to a route-way. 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 route-way as well

as accessibility. But boundaries also have bearing on accessibility. Indicator are devices that have the capability of generating and transmitting information. Information is made up of symbols creating create messages. And messages with meaning that requires a response from the receiver.

Validity of accessibility has two forms: messages that define the boundaries of a route-way, 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. Systems has been added to the title of this study. 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; that is discussed in Semiotics/Semiology. System for T-M needs to go beyond that since com-munication 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 ob-

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jects and between their attributes." (1956, 18 in Nöth). A more closely integrated definition comes from Ratzan, "[a] consistent, coordinated set of components acting together as a single unit toward a common function or purpose constitutes a system." (Ratzan 2004, 1).

The system definition works for a specific T-M Sign System (e.g., a general study of international traffic signs) or a more restricted T-M system (e.g. , a specific railway signal code, the I.A.L.A. buoyage system, or a national aids to navigation system). But a more sweeping notion of T-M as a system probably needs a more general and limited notion of system. Possibly a semiotic sense of sign system in T-M qualifies as a specific system though even here a more restricted concept is at work.

Two specific terms within system include communication system and information system. The former can refer to a limited unit that produces and transmissions symbols. This is reflected in the definition of The Free Dictionary (Farlex): A "facility consisting of the physical plants and equipment for disseminating information." Information can encompass a larger unit of activity as can be seen in a definition of Ratzan: offers a definition with a resemblance to his general systems explanation: "An information systen is a consistent, coordinated set of components acting together toward the production, distribution, or processing of information." (Ratzan 2001, 1).

Communication system can be 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 more limited and general sense.

2) Integrative, ICT & Communication Model

A final term is that of integrative. It was part of the original title of the study. It is not clear what the precise meaning of the word would have been in the 1990s since some dictionaries barely mentioned the word. And if included it would be located at the end of the entry for the word integrate which received adequate coverage. More encompassing dictionaries gave it an entry with a meaning related to integrate. Seemingly it is only more recent sources that have an adequate definition. This is especially true of several online source including The Free Dictionary: "integrative - combining and coordinating diverse elements into a whole." It is joined by a second definition: "integrative - tending to consolidate." The first fits the usage of T-M. though the second version less so. (The Free Dictionary, Farlex 2011).

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 perhaps have application to any form of technology that creates equipment and processes for generating and transmiting messages. That would include T-M as well (http://en.wikipedia.org/wiki/Information_and_communications_ technogy 1-3-11; http://encyclopedia2. thefree dictionary.com/ Information+ and+Communication+ Technology 2011). A final term, Communication Model, can have direct bearing on T-M. It is a concept that overlaps with semiotic constructs. *Foundations* includes coverage of the model which is reprinted in a note at the end of this chapter. (See also "Type of Communication Models." http://www.communication-type.com/types-of-communication-models/).

Note No. 1 Indicators

Indicator has been employed as term for all T-M forms in this study. The term has a less encompassing relationship to T-M forms than signals, signs, beacons. But it is also a safety aid term in contrast to other terms from semiotics and communications.

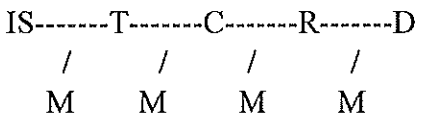
Indicator refers to a variety of specialized signals and related contrivances in railways. It can be a cause of confusion to employ a mode-specific term for an overarching T-M usage. Yet it is more satisfactory than other possibilities. And the railroad usage is limited and not a dominant device.

The core term of indicator is only infrequently employed without qualifying words. In many instances a qualifying term precedes indicator. An exception is Grafton who includes a segment under the heading of indicator though the content refers to a single restricted function. (Grafton 1896, 158-59). There are seemingly two major forms: Route and Junction Indicators are notably employed in UK and Track Indicators. Some other uses are found in switch-related work, and cab signals may employ the term form. Numbers and letters are a common form of message for those uses. Miniature graphic symbols are also employed. Route and Junction Indicators denote status of track availability in a group of tracks. Track Indicators in the past included small signals that gave warning of approaching trains for track repair crews. A final term, Trackside Indicator may suggest a more general usage. But it includes only a few restricted uses (RONT 2008). Further information is found in T-M studies.

Note No. 2 Communication Model

[Reprinted from *T-M Foundations* 2008]

A communication model often cited in communi*-cation 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 such source is Charles Morris. However, only one of his three semiosis formulations includes it. Hérvey's summary of the relevant formulation describes the term as the "whole situation in which the sign occurs ... ." (Hérvey 1982, 47). Morris notes that "the context in which something functions as a sign may include other signs but need not do so." (1964, 47).

The earlier editions of *Foundations* fail to include context. This omission may have stemmed from its limited appearances in the literature. However, it had become apparent that context in some form needs to be included. 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, follows two very different philosophies because of historical exigencies (*T-M: A Historical Survey, 1750-2000*: Ch 3B 1, Buoyage and Beaconage Systems, 1924-1957, and Ch 3B2, IALA Buoyage System). 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. 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; green to starboard are largely in the Eastern Hemisphere (with one exception). Therefore, the context of a given T-M has significant importance 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 (travel-way) 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 routeways are of a rigid pattern. Trains follows a pre-determined pattern in which track and signals have little impact on the track. But the interaction between modes of transportation has a very significant impact on movements. This contrasts with buoys that denote the sides of a channel but have little to do with regulating the passages 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 interact 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-safey 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. Three major issues for parameters are the degree of rigidity in the routeway, the nature of vehicular interaction within the routeway, and the role of physical environment 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 be present. Aero includes vehicle interactions akin to roads in ground patterns 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 are markedly of a control nature. That is the case with railway operations which constitutes an intense control environment that includes few devices outside of a control nature. 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 apart 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 rules affecting the role of T-M forms as well as the rules 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. On-board 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. Mc-Graw-Hill's AccessScience provides information on navigation in a variety of perspectives: Air Navigation (Studenny, 2008), Hyperbolic Navigation (Petersen, et al. 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 represents 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, 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. In

recent years GPS is included as well. Channels can also be described as having an environment nature since channel markings denote the enviromental that is safe for navigation. Boundaries for marine operations are indefinite when contrasted with both rail and road transportation. They 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]aneuvring 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 that are divided into three forms. Road markings are viewed as a means of guidance. Markers also channel traffic and that probably constitute a form of guidance. Traffic signals are obviously control orientated but they can be described in other terms including guidance, regulation and warning roles (Costantino 2008, 3). The control function remains at the core of those activities. Traffic Control Device 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 to sidings. A smaller aspect 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; they provide position information. However, route-ways and safety devices are altered by the place of airport traffic control that adds a direct human and electronic dimension 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.

CHAPTER TWO

INDICATORS, MESSAGES, MEANINGS

2A Foundations

2A1 Basic Message Categories

This chapter focusses on the generation and transmission of messages. It also examines the meanings of messages. It is not an abstract discussion of the process: 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. Those categories are based on the foundations of messages categories developed in early T-M studies in the 1970s. They are not messages in themselves but rather categories in which messages can be classified and described.

The description of the foundations of messages is reprinted from *T-M Foundations* (5th ed, 2008):

This topic is a kind of pre-semiotic endeavor: it does not examine actual messages but instead focusses on the foundation of messages. Messages are shaped and formed by technology and needs of the transportation mode. Messages are not a pure theoretical construct. Foundations of message makes up a bridge linking semiotics, the physical signal, and the transportation mode together.

While it is appropriate to place the foundations of messages in the same sub-chapter as that of semiotics, this

material also touches on all aspects of the study including that of taxonomy since the classification of messages is linked to the classification of T-M forms in 1B (Part A).

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 phases 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 meanings of multiple-messages refers to distinctly different messages at various times from a single marking. Changing refers to the situation in which the messages alternate or change according to some established pattern. A marine light may have a complex message but, nonetheless, it is a single sequence or period which means 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 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 form (U3M). 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 signal. 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 configuration which is unvarying in all cases. In the 1984 [2nd ed., 2004] monograph on traffic control devices it became

apparent that some very different forms of markings were merged together in the UMSM category. The changes made in that category carried forward to further studies in the Series.

The members of UMSM exhibit one of two message 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 term "Programmable Transportation-Markings" while the remainder of forms can be denoted "Unitary 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 a sign denoting the name of a town denotes the "C" form. A fourth variant, "D" has been added to accomodate the individual messages of GPS.

A programmable marking, such as a marine light, can not easily be further sub-divided. 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 transmission is pre-formed and remains stationary though functioning. Many traffic signs, unlighted beacons, surface markings, non-lighted hazard markers are examples of the second form.

Brief technical description of the indicators are included. 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 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 message 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 also is a need for references to physical and transportation

contexts. The entries describe the physical features of the indicator and mean of transmissions. Messages and meanings are considered separately though in somewhat close proximity to the indicator dimension.

2A3 Formulation of 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 14 denoting changing yet single messages (CMSM). 14 is divided into 14.1 for unitary messages, and 14.2 for variable messages. 13 indicates changing message, multiple message (C3M). 23 denotes unchanging message with multiple messages (U3M). 24 denotes unchanging message with single message (UMSM); 24 has two subforms: 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 24.2.3.

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 UMSM
Programmable 24.1
Unitary 24.2
subforms:
Variant A 24.2.1
B 24.2.2.
C 24.2.3
D 24.2.3

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 Rampside-Control Signals
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)
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)

14.2

4121 Flashing Beacon (Intersection Control Beacon in variant classification)

Type 23

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

Type 24

24.1

1500 Radar Beacon Buoy
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 Single Variant, Fixed Fog Signals
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
161 Lighted Whistle 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
421 Lighting Devices: All-lighted and Partly-lighted. All-lighted under 1428. The components include:
    Flashing Warning Beacon (All-lighted)
    Steady-Burn Electric Lamp (day use)
    Warning Lights (first three day)
        Low-Intensity Flashing Warning Light
        Steady-Burn Warning Light
        High-Intensity Flashing Warning Light
        360-degree Steady-Burn Warning Light (All-lighted)
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 Above
330 Signs, Single Forms, Unlighted Aero Nav Aids
331 Signs, Variant Versions, Unlighted Aero Nav Aids
332 Markings,
333 Obstruction Markings
334 Elevated Markings
335 Low-Elevation Markings
431 Warning Signs, Unlighted TCD Signs & Markings
432 Regulatory Signs,
434 Horizontal Markings
435 Vertical Markings
534 Fixed Unlighted Signals, Railway

24.2.3

328 Partially-Lighted Signs
433 Informative Signs
5250 Lighted Signs, Railway Signals
532 Signs, Unlighted Railway Signals, 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.

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.

4128, Lighted Devices, two forms all-lighted.

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

160, 161. Two or more messages are integrated. Coding is 23.

221-224 Day as well as lighted but code 24.1 employed. It is possible to consider creation of a dual message code.

321-325, 327 Coding 24.2.1 employed save for Identification (Code) Beacon when employed in that manner. 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, four forms are day use only.

5250 Lighted Signs, Railway Signals includes a variety of forms so that 24.2.3 is appropriate.

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 employs 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 includes 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 include diverse forms. Many can be coded as 24.2.2. though some can possibly be single forms and other very diverse forms.

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

433, Informative Signs represents the same challenge: whether some diversity or vast diversity. There is a

tendency toward 24.2.3 more than 24.2.2. Signs Giving General Information, 4333, is definitely 24.2.3.

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

435 Vertical Markings contains several groups of safety aid. 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 but perhaps somewhat moderate. 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 absent. Coding for the bells along is 24.2.1.

2A4 Small Categories of Messages

Originallly 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

However, the second and fourth formulations were very small and required little coverage. Changing Messages/Multiple Message 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 "downtime" is a variety of passive message.

Unchanging Messages/Multiple Message 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). They display messages 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. Light ships 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 (*Int'l Marine A/Ns* 2010, 54-55, 143).

2B Unchanging Messages/Single Messages & Changing 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 forms are reviewed later in this sub-chapter.

Indicators need 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 with a lighted portion and a day-portion. It is possible that the day part can be integrated with the light part even with the forms that are nearly all lighted and the day portion is miniscule (or indirectly day-enhanced). The initial topic of this segment considers that issue.

The diversity of Unchanging Messages has a very broad range. Yet the core element of shared message configurations can unite the diverse forms.

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 filters also are a kind of programming. Explanation 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 an ingredient 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 uphold 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 would 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 appurtances. It became a common practice to paint housing and supports (e.g., stems) aviation yellow thereby taking on a measure of a daymarking.

b) Fully-lighted Forms

Approach Lighting includes a unidirectional lamp and an omnidirectional lamp. The former is for high intensity usage. The housing is of aluminum with a parabolic reflector and halogen lamps. The omnidirectional lamp bears some resemblance to runway lamps with short stem and lens. The third unit is the sequence flashing light which is also termed a capacitor discharge light. It is unidirectional with xenon lamp. (Danaid 1991).

Final Approach Indicators include a diverse variety of forms. These units 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 PAR 64 lamps, spreader lens and a narrow slit aperture through which messages are emitted. (*Int'l Aero. 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, inner and outer lens 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). Danaid provides details for the second form. 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 flourescent orange or black and white. Lights may be included for night-time use. (AIP 1990).

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 acylic cover. The cover not infrequently doubles as a lens which often includes a fresnel design. An outer cover is often added. Electric lamps traditionally employed incandescent light bulbs. These have declined in use as other forms including halogen units have increased in used. More recently years LEDs (light emitting diodes) have greatly increased in usage. Newer lanterns often employ solar energy. Some marine forms are relatively short range though often they can be seen for at least several miles. or more. Floating aids employ some of the smaller lantern units employed for land-based installations. (USCG 1964, Ch 5; Pharos marine ca 1991; 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 become more com-plex and more efficient lights are developed. Beacons employed in aviation are used in replacement situations and rare new installations. These are frequently double-ended rotating units. (USCG 1964, 5-12-13).

Message production requires coding devices that create light phase characteristics. This can also be accomplished by the revolutions of 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 actual structure can be secondary or largely obscured as a result. 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 replicated repeatedly and arranged in a design requiring substantial numbers of similar devices. There is a relatively 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 is often in the form of a fresnel lens. The unit consists of a metal base, short stem and ground plate. They are often omnidirectional though some are bi-directional units. High intensity forms contain a outer globe and an inner lens. Message requirements dictate the use of color.The lights are fixed in character (the light does not flash or revolve). They lack a structure that can be viewed as a day dimension. Though it may be possible to regard the tiny physical apparatus and its coloring as a T-M form to some degree. The day dimension for runway and taxiway indicators are the separate entities of surface markings. (Flightlight 2011; *International Aero. T-M* 1994, 105-107).

Inset lights are units nearly flush with the surrounding pavement. They provide functions that overlap with elevated versions. Other functions are independent of above ground aids. The outer cover includes openings for the lamp lenses. Optical and lamp assemblies are within the

lamp lenses. Optical and lamp assemblies are within the below surface housing. Lamps are frequently 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 contemporary forms and updating of old forms. A basic airport identification beacon is the double-ended rotating beacon of 36" diameter. It includes 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. Maritime agencies have employed the beacon for replacements. New versions of the beacon include metal halide lamps and reflectors in place of fresnel lenses. (CAA-446, 1942; Crouse-Hinds 1962; ADB 1991; USCG 1964, Ch 5).

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

Obstruction lights include simple devices as well as complex units that include 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 are represented by steady burning neon lamps that can, in some cases, receive power source from adjoining

there are increasing use of strobe lights that employ flash lamps. High intensity versions are uni-directional while medium forms are omnidirectional. Control devices can increase or decrease the intensity of the lights so that the device can be employed continuously. Some obstruction lights are partially-lighted while others are fully-lighted. Message configurations are uniform despite the character of the light. Obstruction lights are of a unitary configuration. Some beacons of similar form can be programmed for other functions. (FAA 1991 OML, ICAO ADM 1983 24-25, ADB 1992).

Wind Tees are an older device with reduced usage. It is an construction in the form of a "T" and outlined by fixed lights. Wind Cones are indirectly lighted and have a aid to navigation dimension. (FAA 1965, Crouse-Hinds 1962, Danaid 1990).

d) Unlighted Forms

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

A survey of unlighted forms includes a review of employed for indicators, the place of reflectorized materials, and the shapes of indicator forms. Unlighted forms include signs, marks and markers, surface markings, structures. These terms have complex and sometimes uncertain meanings. A simple sketch of major forms can

uncertain meanings. A simple sketch of major forms can suggest the panorama of forms. Signs are vertical objects displaying alphanumeric symbols and graphics in some instances. Message configurations rarely occupy the entire surface of the board underlying the message. Marks and markers can include many forms. In contrast with signs they often cover the surface. They 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 structures which constitute 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 possile 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 remain in use. The underlayers for signs and larger panels employ a variety of materials that include plywood and metal (steel, aluminum, and probably 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 metel construction. The background materials go by several names include backing for marine usage (USCG 1964, Chs 4, 5, 8), and sign blanks for road (US TCD *Handbook* 1983, 2-27).

Reflectorization has become a major material for producing and displaying messages. Sources often refer to retroreflective sheeting though USCG refers to flourescent

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 example, aero signs, according to ICAO guidelines, are rectangular in shape (ICAO AD I, 80). US *MUTCD* has a complex schema for signs that include primary shapes for different configuration 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 messages with their accompanying meanings.

Remarks about marks and markers are somewhat similar to those about signs though message constructions can also be at variance with those of 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 marking of obstructions. The later centers 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 known how much current usage these older forms have. 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 uni-dimensional 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. There are similar message constructs for channel markers, obstructions 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 those are unchanging message forms. Decades ago a kind of fog signal was experimented with in aviation; that was probably a short-

lived event (Sonic Marker Beacon, SA July 1933, 32).

Many marine sound signals are now out of service. Some signals of a standardized nature are still employed. Buoy-based signals continue to be a fairly 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 include 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. Buoy forms were operated at random by the movement of water.

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 probably not a programmed entity. Gongs could be coded when aboard a lightship.

Submarine Signals employed compressed-air and diaphragm versions. Such devices included a coded characteristic.

Source materials include *Int'l 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.*

Railways have employed a form of fog signal (which includes low-visibility) conditions. The aid has several names including 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 represents a diverse range of forms. They are largely confined to aero and marine transportation. However, the growing presence of GPS alters electronic aids and increasingly all forms of transportation including that of pedestrians. Railway signalling includes a small area of electronic aids; road forms generally lack electronic aids though not electronics. Electronic indicators can be divided into five segments: final approach aids, radiobeacons 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 of aero aids.

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. (*American Practical Navigator* (Bowditch) 1966, 942). Potentially any A-M radio station could serve as a Radiobeacon (or NDB). (Clausing 1987, 78). They were single-unit stations. 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, 151-52).

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 aid 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 omni-directional 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 publication, IDAMN 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 than in time. Many systems employed a master-slave systems. 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 used as well as other types 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 be a very different approach yet it too is based on transmitting radio signals. Two dozen satellites cirumnavigate the planet twice daily and supply needed information. Specialized receivers are required for gathering and utilizing the data. The GPS role as indicators produces continuous information which, nonetheless, constitutes mes-sages and meanings. The most complex and sophisticated message producing system is among the smallest physicallly yet the largest purveyor of messages. Differential GPS provide corrected data to receivers. (Garmin 2011, *International Marine A/Ns*. 2010, 185-186).

Kayton 1990 divides safety aids into guidance and navigation. Guidance forms includes two essential systems for aero use: Instrument Landing Systems (ILS) and Microwave Landing Systems (MLS). Both are multifaceted units that constitute one message system. They constitute the final approach and landing aids systems. (Kayton 1990, 3).

ILS has three components: 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 denote relation of plane to approach runway. The Glide Slope broadcasts on a frequency between 328.6 and 335.4 MHz. The message information indicates altitude. Onboard

receiver accepts messages and determines their meaning. The final element consists of two to four Marker Beacons. They transmit on a frequency of 75 MHz and transmits messages that refer to "decision height points." (*International Aero. T-M* 1994, Chapter 37. This is also the reference for remaining topics).

Microwave Landing System broadcasts on 5 GHz frequency which is SHF rather than the VHF of ILS. Localizer and glide slope together create one approach path which is at a fixed angle of descent. Aircraft receivers accepts 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 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 on 108-118 MHz frequency spectrum. It transmits messages of two forms: non-directional and omnidirectional. Aircraft receive information that results in bearing information.

Distance Measuring Equpment (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 information 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. That aid goes under several names including Radio Token. An older system employed physical tokens which admitted a train to a track section. Radio tokens 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 presents 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 be simple in the extreme or markedly complex.

All modes of transportation include unchanging forms. Though they are less represented with rail activities. That mode is largely dominated by signals which control train movements. Signs and markers that supplement the signals. A limited use of explosives has been employed by some rail systems. Road transportation has a more significant level of unchanging forms. These include signs, markers, markings that represent a vast assemblage of forms and messages. A limited usage of lighted beacons (with unchanging messaages) 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

Final Approach Indicators are a complex system with many different kinds of indicators. Some are based on lights only while others involve other principles including patterns and alignment. 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 though in a less than precise manner. The key concern of a flight crew is to descend to the runway at the correct descent approach configuration. The messages and meanings indicate whether a given plane is at the correct level or above or below that level. The various indications forms give a similar message and meaning (*Int'l Aero. T-M,* 93ff). Some systems add well above or well

below messages. One system conveys a well below level message with "gross undershoot signal" in red (Clark & Antonenko 1993, 55).

A long-enduring system but largely obsolete, VASI, employed white (W) and red (R). W denoted above; R below and W/R on course. T-VASI employed white only but combined it with patterns. The on message was denoted by the pattern of lights displaying an aligned design (*International Aero. T-M* 1994, 94).

Approach lighting is both simple and complex. Simple because the message configuration consists of primary lights are steady-burning medium or high intensity in white. Systems requiring additional lights add steady-burning red lights. Appropriate flashing white lights are added as needed. The meaning is a simple one of laying out a clear path for approaching runways though multi-faceted (*International Aero. T-M*, 1994, 85-91). Complexity is generated by a choice of several categories of navigation. Variable intensities of light is also increasing in 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 FHA 1978, 6E1-6E7).

An older Pharos Marine catalogue includes several lighting systems that can be employed continuously day and night. They include high intensity marine traffic lights, high intensity beacons, and xenon flashtube assemblies.

The amount of usage is unknown (Pharos Marine 1991). They provide continous messages with accompanying meanings.

(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 and not simply a general characteristic. For example, a flashing characteristic can take many forms. It can include a 2 second flash and 8 sections of dark in a period or a 4 second flash and 10 seconds of dark among many permutations. USCG altered characteristics somewhere in the 1960s so that the length of flash is no longer given. See light list publications for that decade for comparison of full description and more limited entries.

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).

Obstruction lighting is both partially-lighted as well as fully-lighted. Messages are made up of lights that are steady-burning red lamps, flashing red lamps or flashing white lamps. The meaning remain the same: that of a warning to stay clear of such marked structures. Day markings, when present, can be a dimension of warning messages. (*Int'l Aero. T-M*, 1994, 115-119).

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 to 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 (*Int'l Aero. T-M* 1994, 118).

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, 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 for the message indicate the landing areas and provide information on safe navigation (*Int'l Aero. T-M* 1994, 107-110).

(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 triance 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 which takes several forms), intermittent moving hazards (e.g. pedestrian signs, animal crossing signs), and inter-section signs. (*International TCD* 2004, 108; UN 1969 CORSS 109; US MUTCD 2003, 2A).

Informative Signs appear under several terms. Guide Signs is the term employed in the US term. These signs are very diverse and lack the more cohesiveness 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 posts are possibly part of markers as well (Int'l TCD, 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. IAMM 1967 employed round plates with white ground and 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. *(Int'l 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 (*Int'l 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 occurence and they frequently occupy the full space of the physical object. This contrasts with sign symbols which are present on a sign board but which 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 roughly the size of planks. Geometric designs include diagonal stripes, chevrons, lines are employed and frequently in black on white ground color

schema. Large boards resembling signs are employed in some systems. They can be black on white and serve as halt or stop boards. Sign messages are absent. (*Int'l Rlwy Signals,* 77, 194-197)

Road forms include object markers, delineators, barricades and channelizing devices. Object marker 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; *Int'l TCD* 2004).

iii) Structures

Daybeacons have had a long history with some individual daybeacons 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. Older 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; national administration may have been involved. Those responsible may have at times added color or pointers. Earlier buoyage systems largely omitted fixed beacons. (*Int'l Marine A/N* and its 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). Topmarks enhance the message. 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 determine by an aids of a navigation system (*Int'l Marine A/N,* 165-167; Canada 1975). 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 markings 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 are of a flat rectangular shape and slightly above the surrounding surface. They mark serviceable areas. Stopway Edge markers have the shape of a vertical board. Taxiway edge markers are retroreflective objects displaying in blue. Taxiway centerline markers are retroreflective objects in green. 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, *Int'l Aero. T-M*, 1994, 129-

134).

Other marker forms include wind cones and wind tees (ICAO employs landing director indicator). These are often partially lighted. ICAO refers to them as Indicators. (ICAO 1983, 1990, 35, *Int'l Aero T-M* 1994, 179).

Obstruction markings consist largely of painting objects according to one of several approved patterns in orange and white. (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 is 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. (*Int'l Railway Signals* 1991, 46, 76). Terminology is often confusing. A variety of terms (e.g. indicators, plates, markers) are apparent synonyms for signs.

(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 rapidly declining form though the diversity of now defunct forms remains active for communication and semiotics. (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 was present). (*Int'l Marine A/N* 2010, 7-1). Others operated during periods of fog while others operated seasonally. USCG in the 1970 established characteristics for fog signals. There were just six characteristics; perhaps this was deemed sufficient since many forms were being phased out and diaphragm horns were beginning to dominate. Buoys had two characteristics as well as random operation. (USCG 1979, 7-1).

Some railways have employed detonators for fog and other low visibility. The message takes the form of a small explosive noise. It denotes that a signal is nearby though unseen. (Blythe 1951, 104).

(3) Electronic Devices

Messages for electronic aids are of three types: single units that provide an unvarying message, or an individualized message, or 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 that fixed point of transmission. It aids in determing location but does not provide an exact position. Some units provide bearing information while others add distance data as well (*Int'l Marine A/N*, 2010,

191-192; *Int'l Aero. T-M* 1994, 151).

Hyperbolic Navigation and Satellite Navigation provide data that can be received and interpreted so that the exact position of the receiving unit can be determined. Every message is individualized since it refers to the given position of a vessel at an exact moment. (*Int'l Marine A/Ns* 2010, 185-190).

Guidance aids, ILS, MLS, provide information when approaching an airport. Information comes from several components of the system. Information on altitude, relation to upcoming runway, descent height is a "package" of messages that results in a multifaced meaning. (*Int'l Aero. T-M* 1994, 142-147).

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 but 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 to the point of rarity in this category.

Messages and their meanings are not fully a 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, arrangements of the colors, but the physical background may be much more complex. And the information on the inner workings of message generating equipment can vary greatly. A brief explanation may become superficial in describing these workings.

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 within 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 more centralized control oversees an integrated system of signals. This is notably 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 & 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 semaphores messages are replicated by the more contemporary all-lighted signal. The variety of signals illustrate 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 matched 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 thereby non-visible.

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 CMMM are found in road and rail forms. There are limited forms for aero aids and infrequent marine forms are rare. 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: consistent 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 focus 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 and meanings 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. 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 communication/ information/semiotic rules 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 forms (searchlight signals) and the chart begins with messages and proceeds to meanings. But AAR displays multiple types of signals and the chart presents the reverse pattern: meaning then message forms. Both charts do present coherent information (CNR 1961, AAR 1956).

c) Messages & 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 general manifest a largely 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 augment 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. (*Int'l Railway Signals* 1991, 113-116).

A variety of additional colors are also employed. These secondary colors can be employed to distinguish mainline 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. (*Int'l Railway Signals* 1991, 116ff).

Signal colors and meanings can be similar for a variety of systems. However, frequently there are differences which are ranging 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 permssive 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 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 (US) 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." (*Int'l 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 apppear 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).

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i General Terms

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