T-M

TRANSPORTATION-MARKINGS FOUNDATIONS

6th Edition

Brian Clearman

Mount Angel Abbey

Saint Benedict, Oregon

2013

TRANSPORTATION-

MARKINGS

FOUNDATIONS

TRANSPORTION-MARKINGS: A STUDY IN COMMUNICATION MONOGRAPH SERIES

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- TCD, 2nd ed, 2008 (Part Iiii, Vol III) (lst ed, 2000)
- Aero, 2nd, 2009 (Part Iiv) (lst ed, 2001)
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Transportation-Markings: An Integrative Systems Perspective: Communication, Information, Semiotics, 2011 (Part K, Vol IV).
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Part A, 6th Edition

Volume I, First Studies

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PROLEGOMENA

Prolegomena I: The Original Revisted

The original Humboldt County Prolegomena for Part A has been greatly expanded. The original form is now one of four segments. An older (and perhaps idiosyncratic) memo on how Transportation-Markings studies developed has been added as well as a brief essay on Practical Symbol Prac-titioners. A previously published essay for **Proceedings** *(of the Chartered Institute of Transport UK) is also included in the Prolegomena. The original idea for a Prolegomena comes from Myrna Oakley, a writing instructor, at Marylhurst College (now University) in Oregon. She suggested some personal background for a monograph on Railway Signals. The suggestion was worked on but never included in that monograph. However, the idea took hold during a sabbatical in 1991. The idea took the form of a Prolegomena for the second edition of the Foundations monograph. The original part of the Prolegomena has undergone revision and expansion for the third, fourth, fifth and now sixth edition of Foundations.*

a) T-M Studies

The original volume was a cornucopia if not of delights then of variety and breadth. It was an amalgamation of three previous written but unpublished monographs. The original monographs could be seen as a single body of writings rather than independent entities yet they maintained a distinct identity. The writer, after many misadventures, decided to bring them together and publish them as one unit.

For a time it seemed reasonable to think that the first monograph, *American Transportation Markings: A Study in Communication*, (found primarily in the first two chapters of Part A, and in Part B) would be published without further adddditions. However, the publisher for that first volume (which was part of a series in Semiotics) went out of business and the work went unpublished. During that time a second monograph was written. And while both monographs were sitting unpublished the first portion of a third monograph was completed. Eventually all of these studies came together as Volume I (Parts A-D, University Press of America, 1981).

Three of the T-M studies have been listed by the pre-binding year rather than in the year of the bound volumes. This is the case of Part B (2nd ed.), Part F, Part H (lst ed.). Each was completed save for binding in December of the respective year and bound in January of the following year. All three should have been listed in the latter year.

The second edition of Part A contained a number of new and altered elements. The Prolegomena retained materials, or at least themes, from the first edition Preface. The opening chapter is a revision, enlargement, and reformulation of the first two chapters of the old Part A. The former third and fourth chapter became a single chapter though augmented by a discussion of light. The next chapter, acoustical signals, was a new chapter and reviewed concepts in acoustic as well as examining acoustical signals. Electronic signals processes is also a new chapter. That chapter followed the format of the acoustic signals chapter. The final chapter, also new, examined core ideas of design. These include graphic, geometric and alphnumeric signals as exercises in design processes and the influence of design throughout the T-M spectrum.

The second edition of Part A was a reconstituted version of the original study. It was more of a new monograph than a revised edition since much of it was either new material or a major reworking of first edition materials. Nonetheless, the direction and themes of both editions are similar though with divergent content.

A third edition of Part A was published in 1999. That edition added a segment on holarchy/holonomy (see 1B3 for changes in terminology in the sixth edition) and an expansion and revision of the Prolegomena. The two chapters on lights and colors were combined into one chapter. And the primer sections of the visual, electronic and acoustical chapters were brought into closer alignment with one another. Some additional limited work on the design chapter was undertaken.

The fourth edition of Part A (2005) included a much more extensive chapter on design. A major area of change included a primer with terms and concepts that related to design. A brief history of design was also added. Reworking of the Prolegomena and updating of several chapters completed that edition. The contents of that fourth edition covered 35 years: 1969 to 2004. Differences in time periods, perspective, topics, research materials and handling of materials were reflected in that study resulting in a work that displays a measure of coherence and multi-faceted that diversity. That edition might have been the final edition yet a further “final edition” has been enlarged. New material on semiotics, an increase of coverage on matters cultural and an extensive appendix on T-M terminology and foundations are additional alterations. That fifth/”final” edition is outlined in a fourth segment of the Appendix: iv “Final” Edition. This 2013 (6th) edition is a revisit of that “final” edition. It further bolsters coverage of semiotics as well as other topics of communication, messages and the relation to semioitics. A re-examination of holons and other terms is also included as noted earlier. A larger part of the “revisit” is an examination of a growing need to integrate the several monographs into a single unit of monographs.

A second edition of Part B, *A First Study in T-M: The US*, was published in 1993 (However, the pre-binding date was used). The second edition is a notably different production from that of the first edition. There is a reduction of some materials, a variety of additions, as well as revisions of retained materials. A review of the variety of classifications, explanatory notes and reconfigurations of materials are also included in the study.

The second edition of *International Marine Aids to Navigation* (Parts C & D) was published in 1988. The volume is made up of an introductory chapter followed by chapters on floating aids to navigation, a historical survey of buoys and buoyage systems as well as classifications, descriptions of buoy types, and message systems. Fixed aids to navigation include chapters on methodology, lights, day-beacons, electronic aids and fog signals. Classifications, descriptions of types and message systems are subsumed within the relevant chapters. Appendices are also included.

Two parts were originally assigned to Marine Aids to Navigation since floating aids were viewed as significantly different from land-based forms. In retrospect, one part divided into two sub-parts would have been a better approach. Originally T-M studies were centered on a large chart of safety aids grouped by modes of transportation and intersected by the nature of T-M forms. But the two-part approach became fixed after more than 20 years. That chart necessitated the two-part approach or so it seemed. A new issue has arisen with satellite-based aids. Either a third segment will be needed or a reconfiguration of aids into land-based and water/space-based (or non-land based) forms is required.

A third edition of marine aids was published in 2010. Changes included a general introduction for all aids to navigation. More sections and segments were employed. Substantial changes were added to a variety of types of aids. The internet became a source of information for the subject as well for other major T-M topics.

The first edition of *International Traffic Control Devices* (Part E), was published in 1984. That first edition focussed on TCD systems with a historical undergirding. A second edition in 2004 focussed on T-M forms rather than on systems; history played a more secondary role. The approach of that 2nd edition more closely follows the modal approach of the other monographs with international T-M themes.

International Railway Signals (Part F, 1991; the pre-binding date was employed instead of the fully completed date of 1992), began with a survey of semiotics, physical properties and history. While most of the monographs have not included semiotics in an explicit form there was a perceived need to include semiotic fundamentals in this study. The railway signalling study included chapters on classification, colors and meanings. Other chapters examined the types of signals, signs, markings as well as messages in more specific terms. A glossary of terms and two appendices completed the study.

International Aeronautical Navigation Aids (Part G, 1994), began with an initial chapter dealing with terminology, methodology, and an early history of aero aids. A second chapter took up several forms of classification. Other chapters examined fully-lighted, partially and unlighted aids, and electronic aids including physical equipment and messages. That study ended with an appendix.

Both 1980s inter-modal studies have undergone at least one additional study. While each of the two 1990s editions has had one edition. The only other single edition has been the history survey in the early 21st century. Further editions for those monographs are probably unlikely.

General Classification of International Transportation-Markings (Part H), has had three editions (the first with an alternate title). The original edition was in 1994 (pre-binding date); the second in 2003 and a third in 2010. Part H is a relatively short work that brings together the various classifications throughout the other studies. Two primary chapters consider classifications within the context of transportation modes and message energy forms. A third chapter surveys variant classifications as well as US Transportation-Markings classifications. An appendix encompasses several topics including nomenclature and an index of classifications in the several monographs. The first edition was divided into chapters but not sub-chapters; Section numerations were employed instead (e.g., i, ii). The 2nd and 3rd editions revert to sub-chapters and sections. The 3rd edition has enlarged the sections of older notes. It has also merged two appendices into a new chapter. Source materials in the earlier Preface have been reformulated into a Bibliography.

The *Transportation-Markings Database* was envisioned as a single study though not in a unitary format. Because of the extensive work needed for the Database the studies required an incremental approach which resulted in quasi-autonomous studies. During an "interim" period of time (permanent would be more an appropriate term) it was in four mode segments: Marine Aids to Navigation (lst ed, 1997), Traffic Control Devices (1st ed, 1998), Railway Signals (lst ed, 2000), and Aero Nav Aids (1st, 2001). The Database consists of individual T-M forms listed by dual-indexes and descriptive entries. When necessary treatments of messages and special categories have been included.

The *T-M Database* proved to be a difficult work even after subdividing it into four mode-specific monographs. Each monograph has required a second edition in which errors and omissions could be addressed. Improvements over the first edition have been carried out including the adding of numerous new terms. The first of the second editions is that of *T-M Database: Marine* (2007). The remaining second editions included *T-M: TCD* (2008), *T-M: Railway Signals* (2009) and *T-M: Aero Nav Aids* (2009).

A special component of the *T-M Database* has been the *Composite Categories Classification & Index.* (lst ed, 2006 and 2nd ed, 2012). The first edition includeds new terms which were lacking in the first editions of the modal studies. It gathers together all of the individual classifications of terms into a single classification/index of T-M forms. The second edition adds a traditional back-of-the-book. It includes over 7000 terms in four modal groupings.

Transportation-Markings: A Historical Survey, 1750-2000 (Part J) constitutes a near-final study in the Series. An introductory chapter includes a survey of early T-M forms as well as a survey of the Industrial Revolution(s). A chronological review of visual aids requires two chapters divided into two uneven periods of time. A single chapter suffices for sound signals; one chapter is also sufficient for radio aids.

Transportation-Markings: An Integrative Systems Perspective: Communication, Information, Semiotics is the fifteenth of the studies. The idea of the study goes back to the late 1990s. It can be viewed as a possible reaction to multiple modal studies since it focusses on the integrative nature of T-M studies. The role of core perspectives are given in the title. The study has undergone a variety of possible titles. A second edition is under consideration.

Beginning in 2002 a periodically updated *T-M General Table of Contents with Index* has been published. The current edition is the 8th edition (2011). More recent versions include a General Preface. The first edition was a mere 44 pages while the 8th edition is 118 pages.

b) T-M: A Discipline

This book is about "Transportation-Markings" (here-after T-M). A T-M can be defined as "any device which aids a mode of transportation (ship, plane, auto, train) by giving guidance, by expressing regulations, or by giving warnings." That includes the whole field of T-M forms (also termed safety aids): lighthouses, taxiway lights, traffic signs, railway semaphore signals, radio beacons, buoys, traffic beacons, global positioning systems, fog signals, targets, obstructions beacons, daybeacons, and hundreds of other T-M forms.

There is no recognized discipline of T-M. It began as a notion of this writer and -- perhaps unfortunately -- it remains that. Neither the term nor the underlying concept have met with general acceptance or even restricted acceptance. The whole enterprise remains unknown even in specialized environments where such a study might possibly generate interest. While there are some researchers and writers who have promoted parts of what might be termed T-M they have not included the entire spectrum and scope (with the notable exception of G. Jean). The Library of Congress system of subject headings affords a measure of acceptance of T-M yet only limited use of the term has resulted. One major academic library has misused the term thereby negating what little headway toward acceptance might have been achieved.

Why promote something so unusual, so seemingly untenable? Because these diverse objects -- with their communication dimension -- are, in fact, a single subject. They belong together since they perform the same tasks, refer to parallel modes of transportation and, on occasion, share the same technology. There is, therefore, a need to say that they belong together as a discipline.

If these diverse elements belong together it is necessary to demonstrate the relatedness of all types of T-M forms. It is not sufficient to simply construct a work encompassing the spectrum of these entities. It is also necessary to stress the commonality of the aids along with the simultaneous independence of the forms and their uniqueness. This theme of commonality can be demonstrated in a variety of ways. The theme can be clearly visible when dealing with semiotic and communication concepts, taxonomy and holonomy.

Commonality is also present in less obstrusive ways that are also more pervasive. For example, the classifications highlight the individuality of T-M yet at the same time taxonomy ties T-M forms together by indicating shared characteristics. Vignettes of history and descriptive of T-M forms more than a hint at shared backgrounds and parallel developments. The over-all developments of the monographs hopefully illuminate T-M forms to be a single phenomena with multifaceted and multifoliated dimensions rather than disparate elements with little in common.

c) T-M: Why Not a Discipline Before Now?

This section was substantially written in 1991 which is long before the World Wide Web (a term less often employed now; internet is now more commonplace).While the present situation is at variance with the early 1990s there is more than a little similarity to what was written about T-M two decades ago. The web, or internet, is clogged with references to T-M but many of them run counter to the correct meaning of the term, and the meaning of Transportation Marking in the Library of Congress (LOC lacks the hyphen). There are *also many sources for individual forms of safety aids and to transportation modes on the internet. But these are frequently fragmented and widely separated. The new Transportation Library Catalog (spring, 2004) may possibly be an aid yet the other use of T-M continues its pernicious ways.*

But if T-M forms belong together why are they not already together? If a broad-scope, semiotic and communication undergirded and hololarchy supported non- technical study of T-M does not already exist why start now? One can point to the lack of integrative writings about safety aids and say they ought to exist but why not already exist together? Much of the answer is found in the nature of existing T-M materials: they do exist but only in specialized, fragmented portions. Even the fragments, which may exist for a specialized audience, are mostly unknown to a larger world. For example, publications of the International Hydrographic Bureau, a key source in the past for buoyage materials, are found in few libraries; even a variety of mariners may not be conversant with that literature. Nor are the publications of the International Association of Lighthouse Authorities (IALA) readily available to a large reading public; even libraries with technical collections may lack IALA's publications. Various railways, traffic control and aero publications are found only in specialized collections and unknown by few non-specialists. Only very general works, which are often of a technical nature, would include even brief mention of many forms of T-M. And many internet entries for T-M point primarily to surface markings.

It is not very likely that even a moderately well-stocked library posseses even some of the more essential works on

T-M. And unlikely that many individual would have knowledge of even some specialized publications. This suggests that even a partial awareness of the nature and form of T-M would be in the possession of few people. Though readers with wide transportation interests may be acquainted with a few publications (as well as using some forms of T-M). In many instances only the most general works, which are often of a technical nature, would include mention of many forms of T-M. More specialized works often include a single area of T-M forms and then perhaps only a small segment. The internet has greatly altered the "ecosystem of information" (M. Dowd, NYT 2013). But often the result has been of a scattershot pattern of information: many isolated fragments without a structured pattern and inadequate means of access.

Further, specialists no doubt are concerned primarily with their disciplines; they may have little concern with adjoining disciplines. Mariners, for example, may not see a need for a knowledge of railway signals, nor would auto motorists see a need to know about aero lights. This would be true of operators in other modes of transportation. Though an understanding of other forms of T-M and resulting interconnections would be an aid to operators in a single mode.

A sense of unity of T-M can hardly be conveyed:
If few libraries have publications in all areas of T-M.
If few broader-scope works touch on the full spectrum of safety aids.
If few people have more than a slight awareness of T-M as constituting an integrative discipline.
If the key term is misused on a massive scale on the internet. And if connections between the components of T-M

are not in evidence on the internet because the locating of linkages is blocked by the misuse of the primary term.
If the internet has tiny and disconnected fragments.

Yet an integrative, wholistic approach to all T-M forms can be achieved. T-M can be a reality.

d) T-M: Approaches & Forms

The approach of this study could take an abstract direction. However, the writer has chosen a more concrete approach and one centering on the international character of T-M forms. There have been may efforts at building common systems of aids through international bodies for some T-M systems; while other markings have achieved less than global convergence. Nonetheless, an attempt has been made to draw together the many marking types from around the world. This includes those forms whose source materials have been tailor-made, as well as those forms whose sources had to be woven together from many fragmented strands of materials.

The approach of this study could have been incorporated one of several forms: a technological one centering on how the mechanical, electronic and other devices are designed, constructed and operated. Or a semiotic form with a focus on sign processes at work in objects standing in for other objects (accompanied by the resulting disposition to act that is created in the receiver). Or a communication form centering on physical signal processes (semiotics does not involve the physical signal dimension to a substantial degree though messages/meanings are at work). Or a study giving significant attention to holons and holonomy with each element simultaneously part of another entity and yet having autonomy in itself.

While T-M studies do not ignore the technological dimension, they do not focus on it either. The several studies follows an approach that is holistic and integrative and centers on communication theory, a semiotic perspective and, more recently, holography/holonomy concepts.

e) Underpinnings for T-M

The underpinnings of the several studies of this Monograph Series on Transportation-Markings as Communication dates back several decades. They are founded on a childhood familiarity with a diverse range of T-M forms.

-Traditional lighthouses from Tillamook Rock on the Oregon Coast, Cape Disappointment and North Head adjacent to the Columbia River estuary and Alki Point in Seattle.

-River and Harbor Lights of the Columbia River; often superficially similar objects made up of small houses, boxes, platforms and skeleton towers and marked off by stripes, bands, letters and numbers; further differentiated through unique flashing, occulting or fixed characteristics. The singular quality of river and harbor lights is conjured up by memories of specific lights: the fixed green glow of Garibaldi Light on a misty afternoon in Tillamook Bay; the staccato flashes of Stella Range Rear Light on the Columbia (flashes created by a railway searchlight lantern), the black and white banded daymark of Columbia River Entrance Range Front Light, larger than some traditional lighthouses.

-Buoys of several shapes and sizes and displaying red or black hues. Buoys with bells, gongs, or whistles sounding a message sometimes clamorous, sometimes eerie in storm or fog. The special quality of sound buoys is reflected by the cacaphony of buoys in the Columbia Estuary heard from atop Cape Disappointment; the almost ghostly sound of the Cape Kiwandi Whistle Buoy heard from the moist forest of Cape Lookout in Tillamook County.

-Aeronautical lights from the simple runway edge and end lights of the Kelso airport to the complex approach lights of Sea-Tac; prosaic fixed or flashing red lamps atop electrical or communication transmission towers. Such lights are high-lighted by an engrained memory of the loom of the Rocky Point Airway Beacon guarding the flanks of the Kelso airport.

-Railway signals from more modern color light signals of the Northern Pacific at Kelso to more colorful semaphores: a sen-tinel with square-end blade in red and white in the Chehalis lowlands and a signal with pointed-end blade yellow and black near Vader. And interspersed with the signals were little noticed targets, whistles, mileage posts, and station signs.

The panaroma of marine, aero, rail signals and beacons of the northern Pacific coast, the River of the West, and the Willamette-Cowlitz-Puget lowland, was framed within a matrix of the ubiquitous traffic signal, sign and pavement marking. Objects so common that they may fail to register in the consciousness though they may conceivably became embedded in the sub-consciousness of many users. A utilitarian object occasionally made singular by an ancient traffic sign coated with raised glass beads or an unitary signal with peaked roof or a traffic beacon displaying the embossed word “Go.”

Despite the specificity and restricted geographical milieu of these diverse markings they formed the basis of an interest that went far beyond them and concrete object to a global interest concerned with symbols and their meaning.

Brian Clearman

Humboldt County on California’s North Coast
(McKinleyville/Clam Beach/Arcata/Eureka)
January-September 1991

Revised & Enlarged at Neskowin, Mt Angel &
Neskowin again 1998

Further Revisions at Mt Angel & the Milk Ranch
2004, 2007, 2008

And additional revisions at Mt Angel, Milk Ranch,
& Lincoln City, 2012 and 2013

Prolegomena II: Addenda

i Transportation-Markings (*Proceedings* of
(Chartered Institute of Transport in the UK, June 1997)

Professor John Hibbs (University of Central England, Birmingham*) editor of* **Proceedings**, *invited submission of a brief essay for that Journal. The Chartered Institute of Transport dates back to the early decades of the 20th century and has membership in many English-speaking nations. This Journal primarily reflects British interests. However, Professor Hibbs thought I was "on to something" with this approach to safety aids and kindly provided this forum for T-M.*

Transportation-Markings (T-M) is an integrative and wholistic study of all forms of safety aids in the realm of transportation. T-M can be defined as any device (external to a mode of transportation) that aids a means of transportation by giving information, providing regulations, or expressing warnings. "Safety aids" provides an alternative term though less specific.* T-M views safety aids as possessing a shared commonality transcending the boundaries of transportation modes. Traditionally safety aids are associated with one mode of transportation and not all T-M forms. Railway signals, for example, are attached to trains and track, not to marine aids to navigation, traffic control devices, or aero navigation aids. To be sure, it is reasonable to view these aids in the traditional perspective. From the perspective of a railway engineer or other mode-specific specialist it may well seem odd to view safety aids in any perspective other than that of the mode.

*The General Preface (2010) offers a further correction by specifying the nature of that study: T-M studies symbolic behavior. The apparatus for producing symbols, the resulting symbols and their meaning are at the heart of that study.

Yet an exclusively mode-specific approach to safety aids can have shortcomings. T-M forms are ultimately a form of communication and of direct human communication. T-M can be said to be less a component of transport science than of human communication: the emission of symbols with agreed-upon meanings aiding the movement of people and goods. Because they are part of communication they share a common basis and execution, no matter their form or location. In all fairness, it must be admitted that the traditional mode viewpoint remains a vital and necessary dimension of safety aids. However, the integrative approach can complement the traditional approach by seeing T-M forms first as a component of communication and closely related to all other such forms, and only then as mode-related.

T-M offers a perspective on safety aids through an integrated system of signs (signs in a semiotic sense) forming a single discipline. Within that discipline various forms of energy and symbolic behavior are manifested, yet the substructure of common purpose remains intact. T-M does not so much deny the traditional mode-related nature of specific systems of safety aids as offer an additional perspective from which systems of safety aids for a given mode become active.

T-M can be regarded as a technical subject, yet an integrative and wholistic approach may find fruitful insights in semiotics. There are many definitions of semiotics; the simple one of Pierre Guiraud (1975, 1) will suffice here: “Semiology [or semiotics] is the science which studies sign systems.” Guiraud gives substantial treatment to the various kinds of codes. Codes (or culture codes) are defined by A.A. Berger (1984, 156-157) as "(1) directives in our culture which we do not recognize (generally) but (2) which have a highly articulated structure and which are very specific." Guiraud divides codes into several categories of which "logical codes" is especially vital for T-M. Logical codes, in turn, can be further subdivided; the subdivision of "practical codes; signals and programmes" includes T-M. This category "coordinates [s] action by means of injunctions, instructions, notice or warning." (Guiraud 1975, 45, 51).

Another important perspective for T-M is that of the communication model (Nöth 1990, 174ff). Communication models focus on the material signal element (the physical aspect) while semiotics is more concerned with signs (the mental process). An important model is that of Shannon & Weaver (1949, 7), who outline a linear communication chain in which a signal moves from a transmitter through a channel to the receiver. Both the semiotic dimension and physical communication need to be present for T-M. The General Preface has focussed on symbolic behavior as already noted.

Nearly as important as semiotics and communications for T-M is the study of taxonomy. Dana's System of Mineralology (C. Palache, ed., 1944) has served as a foundation for a general classification of T-M forms. The classification not only lists and numbers T-M phenomena but also clearly illustrates the commonality and interconnections of T-M safety aids. A variety of library classifications also indicates shared elements among the T-M forms.

A final perspective is that of the holon, developed and described by Arthur Koestler. Holons manifest a double nature: holons are simultaneously semi-independent wholes and an integrated part of larger wholes. Each holon contains other holons and, in turn, is contained in other holons. He describes holons as a vast hierarchy (more correctly termed a “holarchy”) with each holons as “Janus-faced.” “The face turned upward, toward the higher levels, is that of a dependent part; the face turned downward, towards it own constituent, is that of a whole of remarkable self-sufficiency.” (Koestler 1978, 27). T-M very much resembles a holarchy with each T-M (attached to a mode) making up a holon while containing other sub-forms or additional holons. Each mode-related T-M holon is a component of the holon of T-M in its totality, and that totality is also a constituent of communication and semiotic forms. Jeffrey Stamps offers an alternate view with the terms of holonarchy and holonomy (see Ch 1B3).

The technical element is not lacking in this integrative approach to safety aids. Rather, the technical is interwoven with social science and communication resulting in a discipline of T-M phenomena which not only encompasses the full spectrum of pheonomena but creates a single study.

Many of the monographs admittedly take up a mode-specific approach (Part C/D, E, F, G) as it is difficult to consider the whole subject in detail in a single integrated treatise. The approach is, however, kept within at least an informal semiotic framework and is firmly grounded in taxononomy. The foundation monograph (Part A, 1991, 1999, 2005, 2008 and this new edition) offers a primer on energy forms as well as an exposition of semiotic, taxonomic and design factors. The US study (Part B, 1992) does take up the spectrum of T-M though confined to one nation. The general classification (Part H, 1994, 2003, 2010), provides a perspective that draws together all of the elements of T-M. The database (Parts Ii-Iv, 1997-2012) provides succinct descriptions of the individual markings. It too, however, remains anchored in the overall concept. Note: more recent editions have been added to the original CIT essay.

There has been some confusion over the meaning of T-M. Some users have interpreted the term as constituting a synonym for pavement markings. This is not the case. T-M is a general, overarching term for all forms of T-M. In order to reduce confusion a hyphen has been added conjoining "transportation" and "marking." This results in an image of T-M as a single and unified concept, thereby reducing misunderstanding over the meaning of the term and especially of mistaking T-M with one of its constituent elements. The end result is a term that encompasses all forms of safety aids including forms that incorporate "mark," "markers," or "markings" in their names.

Newer T-M studies have added several introductory segments. The new edition of *Foundations* includes a formerly free-standing paper on T-M monograph writing and publishing over the course of the project. It discusses the physical aspects monographs, and examines library classification and subject headings as they impact T-M. General Preface offers a schema for dividing the monographs into a three-part thematic construction. Terminology of T-M is covered in the Appendix of *Foundations.* That study was originally a free-standing paper.

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Charles Palache, et al. 1944. *The System of Mineralogy of J.D. and E.S. Dana.* Volume I, 7th ed. New York: Wiley & Sons.

Note: Chapter 1 includes a more extensive review of sources; these references stem from the 1997 essay.

ii Building Construction: An Analogy for T-M Studies

The original draft of this segment is undated but was probably composed in the early 1980s. It was later retyped with minor changes. This draft has been only slightly revised. While perhaps idionsyncratic it offers a view on how the notion of T-M through the various studies came about. It refers to construction as is the case with Addenda iii.

I suppose that a study of almost anything ought to proceed on rational, orderly, logical, systematic foundations. A study of something heretofore unstudied would assuredly follow that pattern even more studiously. And yet in the study of T-M, in the preparation of writings on T-M, and even in the assembling of those materials for publishing. I seem to have followed a different pattern. A pattern key-noted by a scurrying and even rushing about, of throwing together a system, classification, arrangements often without much reflective mulling over of the various components of the study. I think that this can be best explained by an analogy from the construction trade.

It would appear that I have, to some degree and in some sense, prepared the blue prints or at least rough sketches of the edifice of T-M. I have drawn out the outer limits, the sub-dividing lines, even some of the details on paper. Then the paper concepts were laid out on the ground with string and stakes. If there was a slowness and even some measure of reflection in the early stages it vanished as the project lengthened and grew. More and more speed and less and ruminating occurred as the days, weeks, months went by. The framing for the structure at times seemed reasonably rational. The various foundations were set up and poured, the framing was begun. As the framework stretched out in all directions it may have had something of an impressive appearance about it. The studings marched off into the wings and exuding something of a symmetrical appearance.

But things began to happen. Some wings were not needed or so it seemed. Then other yet unbuilt wings were needed. While yet other wings needed to be shortened or lengthened. Foundations were thrown together for the extensions. Unneeded foundations were torn out or simply abandoned. Weeds, vines and other vegetations appeared with almost indecent haste and soon enveloped the abandoned wings. The new wings and framings were often out of kilter with what had gone before. Signs of topsy-turvy began to appear.

Some building materials had to be imported: wood from far countries, and stone, and even some of the metal pieces. As these materials arrived there was no time to slowly and carefully prepare them: no time to trim and burnish and finish them for their intended function. Instead as they arrived they were swiftly bundled off to the right location and wheeled into position and tacked down in some fashion or other. And hardly was that accomplished before yet other materials arrived. Older existing materials also had to be installed. More and more of a frantic pace was observed. Shoveling and wheeling, nailing and stapling. Paint brushes and hammers and nail and paint mixed together and scattered far and wide. Whole wings out of kilter, windows missing, door frames without doors, walls without paint, floors without flooring. As yet new wings were started it became necessary to throw together new parts with whatever was at hand. Some wings were constructed of green wood that had never seen a kiln, nails that had never experienced galvanized dip. Warped and rusting these wings testified to haste it if to little else. Yet other wings ended in mid-air without outer walls or any demarcations at all. Some sections were tolerably finished though mortar was missing or mortar was slapped clumsily on bricks.

And yet, more and more a vast edifice was rising above the plain. The perfectionist would be appalled, the slow of step would probably end in disaster walking in the unfinished galleys, on the unfinished floors, up and down the missing stairs. Architects might faint away, craftspersons would collapse on the spot. But a very few might see something in the turmoil and chaos: a vast outline with order in the assymetry; a vast edifice that was more vision than concrete.

The wings that failed to materialize were dead-ends that had to end that way; the unfinished wings were those that had life but not the wherewithal for reaching a definitive state. Openings and gaps and loose ends were segments that had a form and a purpose and a definition but lacked some unit or several components.

iii Practical Symbol Practioners

This essay has existed only in a state of ruminations for quite sometime but it is only now that it exists in a written forms. It too is eccentric in tone but it does offer an explanation of the undergirdings of T-M. And it too refers to construction.

It seems unlikely that Longview, Washington (and the adjoining town of Kelso) has qualities that would generate such an entity as T-M. That is, qualities which are unique to Longview. There are other mill and port towns. There are other towns with river lights and fog signals, aero beacons and airport lighting, railroad signals, traffic signs, signals, traffic markings. There are other towns not far removed from a coast with traditional lighthouses, from major urban areas with an international airport, the full panopoly of T-M systems marked by both an intense and sophisticated character.

The character of the town can therefore be only part of the generating force. Much of the generating force for T-M is the family. A family where a craft, in this case, carpentry, has been long practiced and with considerable skill. It may be of little consequence that not all members of the family had the skill. Nonetheless, a certain basic attitude, mindset permeated the family and this stemmed from carpentry. It could have stemmed from other crafts as well.

The basic attitude is that of symbolic behavior: creating, reading, acting on symbols. It may be true that this is not a family where abstract thought dominated. It was a family where the concrete, the practical was the order of the day. Yet symbols and their use were at the core of the craft of carpentry and that greatly affected the family. That world of symbols is found in blueprints. Yes: Blueprints; sheets of paper with white lines, graphic symbols on blue paper. What is a blueprint but a mass of interrelated symbols? Each line, each mark is a symbol: each stands for something else: symbols for door openings, walls, foundations, electrical and plumbing systems. One can focus on the skill of a carpenter: walls are constructed that are squared off, nails and screws neatly installed, woodwork that is artistic. But more basic is the ability to know what each symbol means and how to create it in the concrete: a symbol becomes a door, a window, a roof beam. Symbols becomes a way of life deeply embedded in the family.

A professor of theology or of philosophy is very much caught up in symbols. But those symbols are often not empirically based. Such a person could speak at great length about symbolic behavior and be very wrong-headed (though, to be sure, they may often use symbols correctly). And it may not be readily evident when such a person is wrong-headed in using and explaining symbols.

But a crafts person can't misuse symbols without that misuse of symbols becoming quickly obvious. Misread symbols on a blueprint and comic if not lethal consequences quickly ensue.

--Misread the symbol for a bathroom window and instead install the garage door in its place. When the happy homeowner is drying off from a shower and a neighbor activates their garage door opener and the whole wall of the bathroom opens up, the happy homeowner may say "that craftsperson could not read symbols correctly."

--If the plumber can't read symbols well and connects the toliet drain to the shower head the happy home-owner may say, "that craftsperson cannot read symbols either."

--If the electrician installs the 220 volt line for the kitchen range to the outlet for the toaster or microwave, the happy homeowner may not be available for comment.

T-M was borne of Longview and its character, a largely solitary childhood, and a special world in which one thing stood for another thing and those things were interrelated. Gradually an interest first in lighthouses but increasingly with more and more kinds of safety aids became less an interest in picturesque structures and more in what they do: represent dangers, give guidance, convey regulations by something else: that something else being a symbol in light, flashes, colors, sounds, electronic impulses. And that symbolic behavior led to a notion that the various kinds of transportation equipment (ships, planes, trains, cars) were essentially a single entity: practical objects creating and projecting symbolic messages that were essentially the same since they did the same thing.

The shared world of symbols and messages overshadowed the more conventional idea that the various kinds of safety aids that were separate worlds. The world of carpentry and its use of symbols became transferred to safety aids and eventually the concept of T-M came about first in classification then in holonomy.

iv Final Edition Revisited

The “final edition” has undergone a “revisit.” This version has three elements: improved and enlarged coverage of semiotics, the uncertainty of semiotics in itself, and the need to integrate the T-M studies.

The fifth edition increased coverage of semiotics yet that effort was not adequate. For example, the term “message” is a commonplace in the studies and it is found in semiotics yet the use of messages has been rather free-standing and not linked to the use in semiotics. That has been rectified to some degree. Mention of linking semiotics and communication in the 5th edition came to very little. Communication Theory was largely independent of semiotics. Communication is now a larger topic including theory and including ties to semiotics. More definitions of semiotics are included. A separate entity within the first chapter, holon and holarchy, has been substantially altered. Holarchy has a smaller place while a new term, Holonomy, has overshadowed replaced it.

Semiotics in itself has become more problematical. One current leading figure, Ereo Tarasti (IASS), has expressed a concern that semiotics is losing its name and identity as a discipline." (See his presidential address in http://lassais.wordpress.com/). It has been a long-enduring struggle to grasp the nettle of semiotics. It is now disconcerting to consider that the semiotic world may now be disintegrating.

The largest change in these studies has been a growing concern about how to integrate the monographs so they can become a single unit. T-M studies have not worked out very well when separated. The 15 current studies (and 22 past editions of studies and one in process) need to be together. Various ideas on bringing them together has been considered from a "road map" to the individual to a single reconstructed mega-monograph. Various separate efforts have increased the degree of integration. The 5th edition of this study (2008) moved the integrating process forward by including the "3M" Appendix thereby aligning diverse topics. That is one element of an integrating process. But there are other dimensions to con-sider:

-The second edition of *T-M Database: Composite Classification and Index* (CCI) (2012) includes a back-of-the-book index that lists approximately 7400 terms divided into the four transportation modes. While not definitive it encompasses many of the T-M forms in use. It is available only in the 2nd ed. of CCI.

-Two unpublished brief documents, "T-M in Three Parts," and "T-M Project," provide integrating tools. The first outlines a way to reconstruct the monograph project. It is unlikely that will come to pass because of cost and the requirement of extensive work. The second idea outlines and describes the monograph projects as a unit but without merging the studies.

-The General Preface in the *T-M Table of Contents* provides a three-part approach for considering the diverse studies in a unitary structure. But it does not propose a rebuilding project.

-This sixth, and the last edition of this study, can begin to draw together various ways of integrating all of the T-M work. While it may not be able to encompass all of the integrating elements in this work it can at least provide wayfinders leading to them.

v The Semiotics Circus Tent

The original monograph in the 1970s was accepted by Professor Thomas Sebeok of Indiana University for his Studies in Semiotic Monograph Series. The intended publisher was the Research Center for Language and Semiotics Studies at Indiana University. RCLSS required a subsidy for publishing and that derailed the process. A relatively new publisher, Peter De Ridder Press (Lisse, Netherlands), then took up the Series without a subsidy. Unfortunately that publisher went out of business before completion of the Series. And the study was not published. As a result, T-M has been officially apart from Semiotics for these past 30 years.

Yet Semiotics has much to say about T-M: how the individual markings create, transmit messages, influence a disposition to respond in a given way by the user. Admittedly, Semiotics is not an easy tool to understand and to use. Semiotics does not represent a conventional discipline (e.g., history, geology, sociology). Instead, the practitioners are from existing disciplines (e.g., linguistics, anthropology, philosophy, sociology among others) rather than from an fully organized and traditional discipline. What one calls the study of signs (or whatever designation one uses) and how one defines it and how one analyses its working differs from user to user. Yet even an inadequate understanding of Semiotics has helped to shape and direct T-M.

Transportation-Markings has been a part of Semiotics and should continue to be such. Even without a full-scale Semiotic of the T-M components and even if it provides only a brief explanation of semiotics and its place in T-M. To whatever degree T-M can be seen as part of semiotics it is largely due to Thomas Sebeok. As a result semiotics remains an enduring factor in T-M study. The following remarks may explicate the place of semiotics and the role of Thomas Sebeok.

Thomas Sebeok was like a circus ringmaster who welcomed diverse offerings into his voluminous tent of semiotic wonders. A new sign system found a home in that tent. And if possible it was to be published by one means or other. The inhabitants of the tent sometimes included sign systems with the full panopoly of semiotic terminology and explanation. But they also included signs and systems far removed from abstract thought and not infrequently lacking all that suggested a recognized semiotic process. The diverse tent dwellers did have one thing in common: they were part of the world of signs and their meanings and they were welcomed in that tent. Perhaps semiotics is more formal now and less welcoming to non-standardized systems now. But that older and more ecumenical approach has much to recommend it. Something vital has been lost with the death of Thomas Sebeok and his very encompassing approach to diverse sign works.

“We communicate and navigate with a code of logos, symbols, emblems, and signs.”

> Susan Yelavich, *Design for Life: Our Daily Lives, the Spaces we Shape, and the ways we Communicate, as Seen Through the Collections of Cooper-Hewitt, National Design Museum.* 1987.

CHAPTER ONE

THE STUDY OF TRANSPORTATION-MARKINGS IN A MULTI-FACETED FRAMEWORK: SEMIOTICS, COMMUNICATIONS, CLASSIFICATION & HOLONOMY

1A Semiotics

1A1 Introduction to Chapter One

The foundations of this study includes several basic tools and perspectives that introduce an understanding of Transportation-Markings and its workings. These include a variety of semiotics topics as well as additional studies in communication, taxonomy and holarchy/holonomy. The text is divided into semiotics and communication (1A), and taxonomy and holonomy (1B).

Editions before 2008 separated semiotics from foundations of messages, semiotics of objects, and the communication model. While those topics may suggest the physical more than the symbolic of semiotics they remained linked to the symbolic. The 2008 edition merged those topics with semiotics. Yet several aspects, including the topic of communication and messages, were not enlarged to any significant degree. A review of communication and semiotics is included in this edition. Several sources, including those of Thomas Sebeok, are utilized in that review. Messages are closely related to semiotics but they had been largely passed over in previous editions. An increased coverage includes messages as well as the foundation of messages. The communication model and general information on messages are a separate segment but they also refer to semiotics.

An additional dimension of Chapter 1A (The 4th segment) considers the semiotics of the object of Roland Barthes. This topic encompasses both physical and signification concerns. An effort has been made to apply the Barthian idea to T-M.

Chapter 1B takes up taxonomy and holonomy. Taxonomy (1B1) is a basic element for any form of study. It establishes basic rules of procedures and process thereby creating an essential foundation for this study. It also provides linkage between transportation modes and constituent markings with the result that the apparent hidden commonality of markings becomes visible. Some forms of taxonomy in 1A refers to messages rather than the types of T-M.

Holarchy/Holonomy (1B2) is a more recent addition to these studies. Arthur Koestler developed the notion of holarchy over a period of time as seen in several of his works. It has proven to have significance for these studies. Both taxonomy and holarchy involves a principle of hierarchy thereby linking these concepts at least to some degree. Changes have been made in the subject and related matters. A major instigator of the changes is Jeffrey Stamps; other researchers have also altered the original idea.

The chapter ends with Notes on Sources which includes works in semiotics, taxonomy, holarchy/holonomy and related and additional subjects.

The several topics of Chapter 1 are considered separately though they are not intended to be compartmentalized. At least to some degree the topics intermingle and even merge. For example, the foundations of messages are not only a primary adjunct of semiotics but are provide linkage between semiotics, communication, holonomy and classification. The semiotics of the object is linked to "regular" semiotics as well as to taxonomy and technology though technology is not the primary focus of this study.

1A2 Basic Semiotic Concepts

Semiotics is not a highly integrated discipline marked by a notable degree of consensus among its practioners. Nonetheless, it is possible to make some general comments about semiotics that can be applied to this study and the monograph series.

Semiotics has been defined in many ways. It has been viewed as a science by some in the field though others would disagree. Semiotics has been termed a discipline by some though others may disagree. Semiotics is often defined as a study of signs. Yet not a few see that as very inadequate (Lidov speaks of it as a "scant clue," 1999, 1). Thomas Sebeok covered several bases by defining semiotics as "the doctrine, science or theory of signs" (Sebeok in Blonsky 1985, 466). Seemingly only discipline was lacking.

Defining it as a study of signs may be adequate if followed by a further explanation. A second common term found in Guiraud defines semiology as the "science which studies sign systems" (Guiraud 1975, 1). Leeds-Hurwitz includes both signs and sign systems in her definition (1993, 6).

A possibly more recent definition comes from University of Toronto: “semiotics is the science of communication and sign systems.” Sign has been replaced by communication. Does that reflect the focus of their studies center: Semiotics and Communication instead of the older name of Semiotics only. (http://www.vic. utoronto.ca/students/ academics/ semiotics (Accessed: 9-14-12).

Even the term Semiotics is a source of disagreement. It may be dominant in North America (Peirce) and possibly other regions but the older term of Semiology remains significant in Europe because of its ties to Saussare. And there are some who continue to employ Semiotic rather than Semiotics (e.g. Clarke 1987). The three terms have a complex relationship and history that is not easily sorted out. A.A. Berger sums up the meaning of both terms: Semiology “is the science of signs which, for Saussare, ‘studies the life of signs within society’.” While Semiotics “is the system of sign analysis associated with C. Peirce that focusses on the iconic, indexical, and symbolic attributes of signs.” (Berger 1984, 191).

A core term in semiotics is that of sign. For semiotics it is a mental construct more than a physical object. The complete sign assemblage can be said to have two dimensions: the sign vehicle and the multi-faceted sign process with its signification (meaning). Sebeok viewed signification as the meaning of the message (sign) (Blonsky 1985, 466). Deely terms the sign vehicle as an “objectified physical entity” while signs in a strict sense are not “perceptible entities ... .” (Deely 1994, 25).

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

A review of the ideas of Morris provide these elements in semiosis: The sign (a mental construct rather than a physical object) stands for something else (the object). The signification of the sign is the meaning that it has in the process. The symbolic construct that is the sign (with its meaning) leads to an interpretant (Nöth 1990, 174; Sless 1986, 9). An example of signification (meaning) is available in marine aids: a red nun buoy stands for the starboard (or right side) of a channel. The buoy (its redness and shape more than the physical buoy it is also the sign; it stands for the side of the channel, and the interpretant is the disposition to keep the edge of the channel to the right of the vessel. The signification or meaning of the buoy (sign) is: keep that buoy to your right. The interpreter is the party that responds to the interpretant (which is the disposition to a given action not the person responding to the sign). It can be noted that color and shape is part of the sign vehicle as is the physical object.

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

A further dimension of semiotics for T-M is that of codes. Nöth notes that the term became a major element of semiotics through information theory (Nöth 1990, 206ff). Many semiotics endeavors have employed studies centered on codes. As previously noted, Guiraud views Semiology as "the science which studies sign systems" Guiraud 1975, 1)and a key component is that of codes. He has provided a major contribution to codes which A.A. Berger has commented on, and expanded (Berger 1984, Chapters 21-22). Guiraud also influenced Nöth and Wendy Leeds-Hurwitz who also wrote at length on codes.

Codes constitute a major sign system and they can take many forms. Guiraud divides codes into Logical codes, Aesthetic codes, and Social codes. The codes of interest for this study and Series are within the category of logical codes and within that category are practical codes. Guiraud notes that "[t]he function of signals and programmes is to co-ordinate action by means of injunctions, instructions, notices or warning." He further notes that "[t]he highway code, the railway, air space, marine or river codes are among the best-known signal systems." (Guiraud 1975, 51-53). An examination of codes centers more on message systems than on the physical signal though T-M includes the physical as well as the message and its meaning.

1A3 Semiotic Context

The earlier editions of *Foundations* did not include context. That omission may have stemmed from limited appearances in the literature. However, it has become apparent that some form needs to be included. There are situations in which the context of a T-M form (and possibly a group T-M forms) is vital to the understanding of their workings.

Context is a component of semiosis (sign process) in those sources that include it. One such source is that of Charles Morris though only one of his three semiosis formulations includes it. Hervey's summary of that relevant formulation describes it as the "whole situation in which the sign occurs." (Hervey 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 need for context 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 (see *T-M: A Historical Survey, 1750-2000:* Ch 3B1, 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. 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 a few exceptions especially that of central eastern Asia). Therefore, the context of a given T-M has significant importance in marine aids to navigation. Coherent messages are possible but only by placing them in their correct context.

Context can be expanded to all of T-M even if in less noticeable ways. A 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, railway track route-ways are of a rigid pattern. Trains follow a predetermined pattern in which signals have little impact on the track route-way. 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, if any, role in regulating the movement of ships.

1A4 Semantics of the Object

Before the 2008 edition "Semiotics of the Object" as well as that of the "Model of Communication" were placed in the second sub-chapter. That segment was viewed as the more physical segment. In 2008 both elements were placed in the first sub-chapter, 1A, along with semiotic considerations. While placement in the more physical aspect may seem more plausible, links to, or interactions with, the core concerns of semiotics makes more sense. Ultimately a merger of more mental dimensions with the physical may be in order.

Note: Earlier editions referred to "Semiotics of the Object." That was in error: the term is "Semantics of the Object." It can be noted that the remarks of Barthes place this semantic notion within a semiotic or semiology context. (Barthes 1988, 179 ff). According to Nöth semantics "can be found as a synonymous precursor of the term *semiotics.* He also notes that Morris employed *semiotics* as a terminological successor to *semantics*. But Nöth also remarks that Morris viewed semantics "as a branch of general semiotics ... ." (Nöth 1990, 104).

While Semiotics is more often viewed as a study of mental processes, Barthes also examines physical objects and the signification that grows out of objects. Barthes does not focus on the subject of Transportation-Markings yet a semiotics of the object can illumine both the physical and meaning aspects of T-M thereby providing a kind of pre-semiotic state of the physical apparatus for T-M.

Put simply, an object has the appearance or existence of non-human things that continues in existence; Barthes speaks of connotations. The first consists in the existential connotation group. He notes that [t]he object very quickly assumes in our eyes the appearance or existence of a thing which is non-human and which persists in existence, somewhat *against* us." (Barthes 1988, 180). A second connotation group is that of the technological. It refers to the fabricated nature of the object as well as its standardized and often large-scale character.

An object has a use, a function. But objects in themselves are also a “vehicle of meaning.” (Barthes 1988, 182). Barthes employs the phone as an example of meaning beyond that of function. A white phone can convey luxury, feminity. A phone of complexity and mass may convey a bureaucratic sense. An old phone may give a sense of a past era such as the 1920s. (Barthes 1988, 182). Admittedly, those examples may have an archaic aura about them. Probably the current “smart-phones” could be viewed as an example of the semiotic of the object.

Barthes also writes of coordinates and the object’s position at their intersection. One coordinate is that of the symbolic: it acts as a signifier with reference to a signified. The second coordinate is that of classification. All entities have a classification realized or not. And objects undergo classification whether in a factory, a store, an encyclopedia or countless other settings. The meaning of an object may stem from an individual object or from a collection of objects. (Barthes 1988, 183-184).

Some forms of T-M have only limited relationship with the semantics of the object of Barthes (see also, first paragraph of 1A4). For example, unlighted markings such as road signs and pavement markings nearly subsume the non-sign objects that displays the sign with its meaning. Various partially-lighted markings, such as lighthouses, and aero obstruction beacons, utilize both the unlighted and lighted segments of the object to produce messages. Yet fully-lighted signals, especially those of railway systems, maintain an object that is not a direct part of the marking: the signal mast, bridge, ladder, etc. They constitute an object that is not a marking yet clearly denotes a T-M form. A visual sighting of such a signal installation, even if the lighted portion is obscured, portrays a semiotic or pre-semiotic message, a T-M message. And the physical object that directly produces and emits messages can denote a message apart from the actualized message producing function. For example, a sighting of a traffic signal apparatus indicates a signalized intersection in which messages conveying actions to be present. And a signalized intersection during a power outage continues to convey messages of risks in the intersection despite the lack of signalized messages that would otherwise not be present.

Perhaps one can say that the totality of the T-M is a semiotic sign: for some markings the object and the sign are virtually identical; for other markings the semiotic sign and the physical undergirdings can be separated yet both, though in differentiating ways, denote a message producing and transmitting phenomena.

1A5 Messages

The older Foundations of Messages section has been renamed Messages. It includes older Foundation material and also a newer general coverage. So far, these studies have included only brief references to messages in semiotic-related passages. The references have been for the most part directly linked to T-M subjects. The one extensive general selection has been that of Foundation of Messages which has been labelled as a “pre-semiotic” study. However, messages under that title have had a larger role in semiotics. This is evident in a variety of sources including those of Thomas Sebeok.

Thomas Sebeok has written that “the subject matter of semiotics ... is the exchange of any messages, whatsoever, in a world of *communication."* (Sebeok in Blonsky, 451-52). How is a message defined in this context? It is "a sign or a string of signs, transmitted from a symbolic producer or source, to a sign-receiver, or destination.." (Sebeok, above). The question can be asked: Why does Sebeok employ message instead of sign directly? Are some signs non-message in nature just as other signs are message focussed? Message is clearly listed as a type of sign. This use of message is prominent in some Sebeok writings though infrequent in other writings. A possible explanation on the use of message with meaning can be found with Alfred Lang.

Alfred Lang (University of Bern) has explored the types of semiotics signs extensively. He notes that "[s]tudying signs can focus; a) on signs as a special kind of object, b) on the meaning of signs, c) on the use of signs, and d) on the effects of signs." (Lang, "On types of semiotic"). He also notes that "[s]emiotics as the science of meaning is both a development of and a reaction to the centrality of the sign-object pairing." Messages as sign is centered on meaning of semiotic process while other forms seemingly do not have a direct message core.

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

Messages are not a pure theoretical construct. Instead, foundations of messages construct a bridge linking semiotics, the physical signal and the transportation mode together. Foundations also touch on all aspects of the study including that of taxonomy since the classification of messages is linked to the classification of T-M forms in 1C.

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 dialetical 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 refer 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 indicates one message. There are few examples of C3M outside of road and rail signals. Other varieties of railway signals (search-light, position, color-position) follow the C3M pattern though the manner of execution of the message varies from one signal type to the next.

The changing message/single message (CMSM) type suggests a contradiction since change and a single message sequence are in one message formulation. A reasonable explanation is possible: some markings contain one message but that message is not continuous. For example, a road signal at a school may only operate during school hours, or a draw-bridge 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 sequence which is unvarying in all cases. In the monograph on traffic control devices (lst ed, 1984; 2nd ed, 2004) 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 messagee could be programmed for the mechanism) or they produce a single message and are incapable of any other message. The former sub-category can be termed “Programmed Transportation-Markings” while the remainder of forms can be denoted “United Markings.”

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

A programmable marking, such as a marine light, can not be easily 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.

1A6 Communication

The two entities of semiotics and communication can be separately described and defined. Yet confusion over the meaning and distinction of the terms is frequent; convoluted intertwinings are commonplace. It would seem that communication as a technical process of producing and transmiting signals, and of semiotics as a seeking of meaning of signs would not be difficult to distinguish yet it is. There are other issues regarding these two entities. For example, Sebeok and Jakobsen speak of an "integrated science of communication" with semiotics as a "pivotal branch" of that science. (Sebeok in Blonsky 1985, 451-52 with references to Jakobson). Others speak of a semiotics of communication (S. Rajalakshmi 2009; Nöth 1990, 172). That form of semiotics seemingly examines the physical production of messages and their meaning. In T-M the meaning of messages within a technical process has reference to semiotics.

A model often cited in communication theory is that of Shannon and Weaver. That model constitutes a "communication chain" that includes an information source, transmitter, channel, receiver, and destination.(Nöth 1990, 174-75). "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, 174-75). A simple representation of the chain can take this appearance.

```
IS--------T--------C--------R--------D
     /          /          /           /
   M         M         M          M
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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. (Nöth 1990, 174). The communication model with its information source and transmitter encompasses the total communication process though not the subject matter that needs be qualified. It includes the element which produces and projects the apparatus as well as the mental dimension.

While signs within a model of communication are lacking (sign vehicle and meaning) and signals are a physical element there are implied signs within the message dimension of the model: "[T]he message is equivalent to a text." (Nöth 1990, 174). Text semiotics suggest linguistic behavior. But it can refer to "messages of any code." This form of text study engages in an "analysis of nonlinguistic signs and codes in texts." (Nöth 1990, 330-331). Text is a basic concept in semiotics but not included previously in these studies.

1A7 Semiotics Then & Now

The promise of semiotics as a "general theory of signs" may have been bright 30-40 years ago. Publications from small academic journals (e.g. *Bulletin of Literary Semiotics*) to treatises large and small (e.g. Eco, Guiraud) suggested a burgeoning enterprise with a future of growth and significance.

Yet it now seems shrunken and if not shrunken then existing in lengthening shadows. An amateur on the edges of semioitics may have little more than an impressionistic view of semiotics and the changes over four decades. While those impressions may be incomplete and flawed they may suggest the troubled course of this study.

--In past academic libraries whether small or large were building up notable collections of semiotics. Often those collections are increasingly stagnant and worn. New titles are infrequent if not rare. The causes of the decline can have several forms: Fewer money for books. Fewer titles available. Fewer titles that are designated as semiotics. Those reasons and more are at the heart of the problem. A vast library such as the University of Chicago continues to add to their collections yet increasingly the titles are narrow in scope and more than a few are not classified as P99. Titles more or less of general scope have become

--A basic term such as message has been removed from semiotics in some instances and assigned to what is termed Media Studies.

--New terms including Cultural Studies, Communications and Media Studies reduce the scope of what was Semiotics.

--Examples can be found of Semiotic terms and centers that are joined by other terms such as Communication. Semiotics is thereby reduced by the process, and Semiotic study centers have been eliminated or reduced to a single component of a broader terminology.

Yet the general theory of signs remains a possibility. A study can provide that elusive general theory of signs. The following remarks in this subset focus on the critique of semiotics by a learned practioner: E. Tarasti, and ends with a review of a possible way out of the issue that is found in Thomas Sebeok and Roman Jakobsen.

E. Tarasti provides a clear and disturbing view of the state of semiotics (On the Eve of the World Congress in Nanjing: Presidential Address, 9-05-12, IASS-AIS). He notes the frequent use of alternate terminology in semiotic research yet the term semiotics is rarely employed. In his address he also gives an example of the use of a term other than semiotics. That term, Cultural Studies, is often employed in what is frequently semiotical work. Yet rarely is the word semiotic included in those studies despite its centrality.

He discusses further the paradoxical character of semiotics. On the one hand semiotics has had wide influence: ideas and semioticians have had impact in many places and fields of study. This has resulted in a "universal conquest, establishing its presence in a plethora of domains." But on the other hand "this success has taken place at the cost of semiotics losing its name and identity as a discipline." (Tarasti 2012).

Tarasti further remarks that "[t]he old idea of a *disicipline*, which was the center and core of all academic and scholarly activity, is fast disappearing. The notion is regarded as outdated. And younger scholars often focus on a given problem without the discipline with its "methods and tools." "To put it brutally, semiotics have been 'stolen' by other fashionable and up-to-date looking fields, such as cognitive studies, cultural studies, etc." And, finally, [o]ne has to admit that the term appears side by side with such fields as communication, multimedia, multimodality ... and often subordinated to them." Another term, media studies is often employed in the US. (Tarasti 2012).

A possible solution to the problem of semiotics and other studies that refer to communication may be found in Thomas Sebeok and Roman Jakobson.

In his essay "Pandora's Box (in Blonsky's *Unsign* 1985) Thomas Sebeok referred to "[s]emiotics, the pivotal branch of the integrated science of communication..." That reference is to a remark of Roman Jakobson (*Main Trends in the Science of Language* 1970. 33). According to Jakobson linguistics and semiotics are placed within a communication studies framework. There are three studies involved: linguistics, semiotics, social anthropology and economics. The three studies are concerned with similar issues on several levels. According to Nöth, Jakobson "did not propose a pansemiotics view of the sciences." (Nöth 1990, 76). Instead he provided an overarching structure in which semiotics had a critical role.

A possible solution to the growing conundrum of semiotics and other newer, narrower studies may be found in the older approach.The terms semiotics and communication could be part of a rebuilding of not only semiotics but also of communication and areas of study that are linked to communication. Semiotics would have a pivotal role as a general theory of signs accompanied by a variety of recognizable specialized fields of study (e.g., media studies, etc.) gathered together under the heading of communication The core role of communication could provide a crucial place of communication theory. That may lead to an ending of gradually removing elements of semiotics to newer and perhaps ephemeral studies and also of eliminating the growing anonymity of semiotics.

1B Taxonomy & Holon/Holarchy/Holonomy/Holnarchy: Expressions of Singulars, Parts, Wholes & Transportation-Markings

1B1 Introduction

Taxonomy (or Classification) has been a long-enduring element of T-M dating back to the 1960s. More recently, Arthur Koestler's notion of holons and holarchy has been added to T-M in the late 1990s. The use of Koestler's terms and his persona have undergone review that creates a more complex situation both of terms and of Koestler. A brief statement about the later is added at the end of this sub-chapter. Additional terms, Holonomy and Holonarchy have been added that creates a more complex picture. The changes include the use of Holon plus Holonomy more than the use of Holon and Holarchy.

Both Taxonomy and Holonomy (the latter with qualifications) can encompass the individual T-M as well as the totality of those forms and relationships. Each has its uniqueness through some degree of overlap, of interchange is present. They offer perspectives that both parallel and diverge from each other. However, they complement each other more than they diverge. Taxonomy presents an arrangement, a system built up of the individual objects. Holonomy (see above) presents objects (holons) that are simultaneously wholes and components of larger wholes.

A T-M study requires a bringing together -- in a manner both compact and comprehensive -- the varied and diverse elements that make up the field of T-M. The lack of any existing integrative approach makes that “bringing together” yet more imperative. The approach for providing that linkage for this study is traditionally that of classification. It can both provide points of connection, and also uncover pre- existing connections, and areas of commonality between and among markings.

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This sub-chapter includes rules of nomenclature for the monographs. It does not include the actual classifications which are found with the specific treatments of various groups of markings. All of the studies are needed by the observer in order to grasp the full range of classifications. A general classification (Part H, lst-3rd eds) draws together the individual taxonomies.

The approaches to classifications in the Monograph Series have taken several forms: Part B, concerned with the US, has three classifications: visual representations, and outline by type of marking, and outline by nature of message. Parts C and D classifications are incremental in nature: separate classifications are provided for buoys (there are two classifications for buoys: one in outline form, and one in visual form), and for each area of fixed markings (an Appendix in the 2nd ed. provides a general classification). Parts E, F, G contain unitary classifications; that is, the entire classification is in one place rather than an incremental form by the nature of the marking. Part F also contains a variant form because of the many forms of signals. Part H provides a gathering together of classifications. Messages can also be classified (see Ch 1A).

1B2 Nomenclature

The nomenclature (or rules) for naming and classifying T-M forms were established in 1969 and 1970 with an alteration to the rules in 1984. The classification system has been substantially influenced by the Dana System of Mineralogy (1944 edition, Charles Palache, et al., editors). The Dana system employs numbers as well as names for mineral specimens (The 1997 edition, Richard Gaines, et al., editors continues the use of numbers which are set off by decimals).

In a sense the schema adopted for T-M forms is not a “natural” pattern since there is no pre-existing natural T-M arrangement as such. But neither is there an artificial pattern since the elements of the classification reflect the safety aids systems developed by the several transportation modes.

The classification system has four levels (each represented by a single digit): the mode of transportation; the nature of the marking; the classes of markings (when applicable); and the individual markings. Marine aids to navigation have been divided into floating and fixed submodes. A possibly third submode for space-based aids has so far not materialized.

Other arrangement by mode of transportation are possible. Historically, road safety aids are probably the oldest followed chronologically by marine, rail and aero. There are other factors supporting the present arrangement: marine aids are not only long-enduring but they manifest complexity and diversity on a global scale. Many aero aids are unlighted or partially-lighted. Many aids are of an electronic nature for both modes. Aero aids are less in a traffic control mode than road or rail; this is also true of marine aids.

Historically, key marine and aero aids shared a common name: Beacon. In addition, the “beacon” form is a commonplace of marine and aero aids while the “signal” form is a major form for many rail and road safety aids. Road and rail have more defined routeways (or travelways) than aero or marine; that is especially true for rail transportation. The term traffic control has a more definite meaning. The taxonomic order of marine, aero, road, rail is therefore a plausible arrangement for the primary classification.

The nature of the message number is denoted by the second digit that follows this arrangement: fully-lighted visual message are represented by “1” (e.g. rail and road signals). Partially-lighted markings are listed under “2”. The original classification attempted to distinguish between over 50% lighted, and those exactly half-lighted. That is a difficult, and nearly impossible, distinction to achieve. A complex, digital process might, for example, be able to ascertain that a lighthouse is precisely more than 50% lighted (since the need may be greater at night than in daytime), and a railway target with switch lamp is exactly half-lighted and half-lighted. But a preliminary study does not allow for such distinctions.

Number “3” denotes unlighted markings (signs, pavement markings, buoys without sound or light mechanisms). Acoustical signals are “4” in the classification and electronic devices are “5.” Markings with messages from two different categories are listed under “6” (e.g., a lighted sound buoy). Because of changes in the system and in different monographs it will eventually be necessary to examine and alter the numbers of some T-M forms in older classifications.

The third digit number is not required for all markings. It is needed where there two or more groups of marking are found within a message type. For example, there are several forms, or classes of unlighted buoys: nuns, cans, spars, etc. The third or class number designates the various groups. In this classification the third digit “1” marks a nun buoy. A “0” will be found in the third digit position when classes do not exist.

This last digit denotes the specific marking number and allows for up to ten members for a specific classification sequence. For a conical buoy in the international classification the total number is 1310: indicating it is a buoy that is unlighted (13), that it is the first member of a group of more than one type of unlighted buoys (131), and the “0” indicates there are no other forms in that category.

A classification problem occurs with traffic control devices. Traffic signs merge the type of sign (in a physical other-than-semiotics sense) with the messages (sign-in-a-semiotic sense) with the result that the traffic sign has a fixed and very narrow message instead of a single marking which can be programmed for many different specific message characteristics (such as a marine light). There are many types of signs each with one message. This classification is of types not messages but since traffic signs closely unite type and message they cannot be readily “broken apart.” This has meant that the last digit does not represent individual signs since they are semiotic signs (with meaning) more than physical signs (sign vehicle) and therefore the fourth digit becomes a referent to groups of signs. For example, under 432, Regulatory signs, there are several categories of signs for prohibitory purposes and each of these can be divided into sub-categories (e.g, those dealing with turns are numbered 4323). A message for a sign affects the physical appearance of the sign as a physical unit and is therefore within the nomenclature of the classification.

In summary, the T-M classification follows this pattern:

First Digit: Mode of Transportation: Marine (in two parts), aero, road, and rail.

Second Digit: Nature of the message (visual, divided into all-lighted, partially-lighted, and unlighted), acoustical, electronic, combination.

Third Digit: Classes of a given form of marking when applicable.

Fourth Digit: Individual marking number (altered to a group of closely united markings when numerous).

Numbers employed:

First Digit:	1 to 5
Second Digit:	1 to 6
Third Digit:	0 to 9
Fourth Digit:	0 to 9

1B3 Holon/Holonomy/Holarchy/Holonarchy

Holon and Holarchy have been a factor in T-M studies beginning with the 1999 edition of *Foundations*. Arthur Koestler coined both terms. A relatively simple and straight forward account of terms and usage is present. Yet the simplicity has been eclipsed by two events. The first is that of Koestler as a person. He is viewed increasingly as a disturbing presence. One writer, William Skidelsky, refers to him as a "flawed crusader" and notes that his "reputation has been badly damaged by his own character flaws." He goes further and speaks of Koestler's "appalling failings as a man." (W. Skidelsky, *The Observer*, 2-13-10). Yet the same writer questions whether his accomplishments have been entirely dimmed by those severe shortcomings. Nonetheless, Koestler's coining of terms and concepts and their widespread usage remains overshadowed by his life. But seemingly there are no other comparable terms and concepts.

Arthur Koestler coined his terms Holon and Holarchy before the existence of Transportation-Markings. This researcher was slow to grasp the significance of holon for T-M despite reading an account of holons and holarchy in Toulmin's *Return to Cosmology* (1982). Only in more recent years has the holon gained significance for T-M studies. Koestler wrote of hierarchy, holons and holarchies in several books which are listed in the Bibliography.

Koestler's ideas are complex and only certain aspects need be reviewed here. Two key words are parts and wholes. Koestler notes that the word "parts" suggests something that is a fragment, not complete, lack autonomous life. The word "whole" suggests something complete by contrast. Koestler denies the existence of parts and wholes in a full sense. It is his view that an organism constitutes a whole which consists of sub-wholes and sub-wholes, in turn, have sub-wholes. (Koestler, *Janus* 1978, 26-27).

Instead of an organism undergoing processes it is a "stratified hierarchy of sub-wholes." (Koestler, *Janus*, 1978, 27-28; includes paragraph). A diagram of inner-connected sub-wholes present a pictue of a pyramid (or upside-down tree) in which sub-wholes are nodes and the lines connecting the nodes are communication and control channels. Hierarchies in many forms constituted a major pre-occupation of Koestler. He recognized that the term had a perjorative meaning at least for some people and possibly many. He therefore coined Holarchy as a substitute. A holarchy is an arrangement of holons with their Janus-like character (Janus was the Roman god of doors with faces in both directions). It has already been noted that Holons are wholes and parts but not Holarchy which contains wholes (namely Holons with two dimensions). (Stamps 1980, 9).

The term sub-whole can be joined by other entities including "part-whole," "sub-structures," "sub-structures" and other less than graceful terms. To avoid the awkwardness Koestler devised Holon. Holos comes from the Greek with the meaning of whole. The suffix "On" (found in words such as neutron, proton) can denote particle, part. Holon then is a sub- or part-whole. (Koestler, *Janus* 1978, 33). Editorial remarks accompanying *Janus* speak of holons as having "a dual tendency to behave as quasi-independent <u>wholes</u>, asserting their individualities, but at the same time as integrated <u>parts</u> of larger wholes in the multi-levelled hierarchies of existence." (Koestler 1978, *Janus* editorial remarks).

Holons manifest considerable autonomy: they are substantially self-regulating, and display integration in themselves. At the same time they are parts of yet other categories or holons. They are janus-like in character: one direction manifests dependency while in the opposite direction they are largely autonomous.

Some T-M forms may constitute isolated monads though many if not most resemble holons and holarchy. A channel buoy rarely exists in a solitary manner but is integrated with other buoys marking channels, obstructions among other roles. An airport taxiway light is one of many in that function. Each buoy or taxiway light is a holon but they are in turn part of the holon of marine aids to navigation, and aero navigation aids which then become part of the holon of T-M. Even isolated T-M forms display characteristics of the code system to which they belong. Codes are also vital to Koestler's thought. He notes the place of codes for the structure and function of holons. (Koestler 1978, *Janus*, 30). This can suggest the place of codes in semiotics.

Notes on Sources

Each of the editions has added sources which pertain to semiotics and related disciplines (including communication, classification, holonomy) and that have an impact on T-M studies. The 1991 and 1999 editions contribute the most titles while 2005 the least. This edition adds further titles and reorders some titles (Transportation and Holons/ Holarchy/ Holonomy/Holonarchy). Comments are added to titles and reordered materials. A general Bibliography is also included in the monograph.

Among semiotic works of note is that of *Theory of Semiotics* by Umberto Eco. It is a more ambitious work than of Guiraud. It provides perspectives on semiotic phenomena with considerable attention to the visual. Eco includes some T-M forms though in a rather fragmented sense. A researcher conversant with both semiotics and a subject discipline may be able to apply the basic notions to a specialized work. Though for this researcher, and this study, the work of Guiraud is more valuable. The ideas of Charles Morris and Roland Barthes also have bearing on the study.

Pierre Guiraud's *Semiotics* is a very compact work but written in an understandable manner and with a focus on the place of codes. His work has prove to be of great value for this study. A.A. Berger has written a work of semiotics entitled, *Signs in Contemporary Culture.* He devotes two chapters to codes; a coverage influenced by Guiraud though expanded. Two other more recent works in semiotics that give considerable attention to codes are *Caged in our Signs: A Book About Semiotics* by Kyong Liong Kim, and *Semiotics and Communications: Signs, Codes, Cultures* by Wendy Leeds-Hurwitz. Guiraud has been a factor in their work as well.

Two terms that encompass a wide spectrum of semiotic topics and themes are Winifried Nöth's single volume *Handbook of Semiotics*, and the three tomes (volumes) *Encyclopedic Dictionary of Semiotics* edited by Thomas Sebeok. Both provide a coverage marked by diversity and depth for the discipline of semiotics.

Thomas Sebeok has written and edited a great many essays, books, and entire series. An essay that sums up and survey his work has been written by Eugen Baer. His essay, "Thomas Sebeok's Doctrine of Signs" appears in *Classics of*

Semiotics edited by Martin Krampen (1987). The essay includes a bibliographical sketch of Sebeok along with an exposition of his work and an extensive bibliography.

A work more recently uncovered is that of Georges Jean entitled *Signs, Symbols and Ciphers* (ET 1998) He includes a chapter that is similar to the approach of these studies. It thereby provides a stronger context for T-M within Semiology/Semiotics. This work is discussed in the Prolegomena: Revisted iv.

A more general work in communication is that of the four-volume *International Encyclopedia of Communications* edited by Erik Barnouw (1989). It includes semiotics and many other topics with connections to communications. Two other works of a broader scope have involved semioticians: Marcel Danesi's *Encyclopedic Dictionary of Semiotics, Media, and Communications* (2000) and that of Daniel Chandler and Rod Munday entitled *Oxford Dictionary of Media and Communication* (2011). Both authors are interested in media and communication; Chandler is also active in semiotics. The work of Shannon and Weaver, mentioned in many works, is available in *The Mathematical Theology of Communication.* (1949).

There are few works that include a wide range of T-M forms in some detail. One such work is the *Symbol Sourcebook: An Authoritative Guide to International Graphic Symbols* by Henry Dreyfuss. While his work is not an exhaustive treatment it does come closer to a full-length treatment than perhaps any other work. Dreyfuss intended a symbol databank that would continue adding symbols. But with his death the project was discontinued. Martin Krampen's "Signs and Symbols in Graphic Communication" (*Design Quarterly* #62, 1965), Rudolph Modley's Graphic Symbols for World-wide Communication" (in *Sign, Symbol, Image*, 1966) and *Handbook of Pictorial Symbols* (1976) provides coverage of many forms though the coverage is restricted to the visual, and especially graphic symbols. Both of Modley's titles also provide classification of symbols that can be applied to many forms of T-M. An additional work that encompasses aspects of T-M in all modes is *Navigation: Land, Sea, Air, and Space* edited by Myron Kayton, 1990.

More recent works in signs and symbols include *Official Signs and Icons 2* by Mies Hora, 2005, and *Wayfinding: Designing and Implementing Graphic Navigational Systems* by Craig Berger, 2005.

The primary source for the classification is the *Dana System of Mineralology* by Charles Palache, et al. (Volume I, 1944). This edition, though perhaps dated for mineralology, is very adequate for the classification system.The 7th edition was partially completed in 1944 with further volumes in 1951 and 1962. The 8th edition, *Dana's New Mineralology* (1997), was prepared by Richard V. Gaines and six other collaborators. It retains the older classification system but with the addition of decimals.

Holons and Holarchy has been included in several editions of this work. The focus has been on the writings of Arthur Koestler which introduce and explain the workings of the basic terms. However there are other terms that join and alter the original ideas. Other terms include Holonarchy and

Holonomy can be substantially linked to Jeffrey Stamps. Explanations of terms and changes are discussed in Ch 1B.

A more recent addition is the work by L. Hoel, N. Garber, and A. Sadek, *Transportation Infrastructure Engineering: A Multimodal Integration.* (Toronto: Thomson, Nelson, 2008). The writes note that “Transportation Engineering” at time has had the meaning of highway engineering along with some public transport issues. This new title offers a multimodal approach placed in a societal context. It offers a full coverage of the topic and in an integrated manner. While not focussed specifically on safety aids it does indicate a more integrative view.

CHAPTER TWO

LIGHT & COLOR PROCESSES & VISUAL T-M

2A Primer on Light & Color

2A1 Light

a) Introduction to Chapter 2

This Chapter and the following two Chapters focus on energy use for T-M forms. The beginnings of this theme goes back to a slender monograph of 1977. That first effort consisted entirely of color usage for visual T-M. It omitted light, electronics and acoustics. The monograph joined the original DeRidder manuscript (semiotics) and that consolidation was joined by the first T-M modal study of Marine Aids to Navigation. The three components became the original Transportation-Markings study (The 1981 UPA edition).

The 1991 edition revised and amalgamated the four chapters of color in the UPA edition into two chapters. However, chapters were then added for electronics and acoustics. The 1999 edition merged the remaining two chapters on light and color into one. The 2005/2008 editions revised and enlarged the single visual chapter of 1999.

Chapter 2 begins with the topic of light, continues with color as a dimension of light, augmented by a review of essential aspects of color and finishes with remarks on the uses and influences of color in T-M. References to sources follows a standard format in some instances while other follow a standard format in some instances while other references have a more general character, or refer to other T-M monographs. There are several elements involved in an understanding of the nature of lights. Admittedly a reading of limited color sources can present a contradictory or at least a paradoxical explanation. Though divergent understandings can also display a measure of convergence.

b) Rudiments of Light

Electromagnetic energy has several forms including that of light. The physical character of radio waves and of light waves is also a form of radiant energy (Murdoch 1985, 14; Bloembergen 1985, 655). Older theories about the character of light included ideas that light waves consisted of rays or corpuscles (particles). More modern notions began in the 17th century and the foundations of contemporary studies were established in the 19th and early 20th centuries (Ditchburn 1976, 15).

James C. Maxwell developed the Wave Theory of Light in the second half of the 19th century (undergirded by the work of several others in the 17th and early 19th centuries). This theory received a high degree of acceptance. In summary, the theory stated that light waves were electromagnetic waves and, hence, the same as any waves produced by electrically generated radiation except for wavelength (Brill 1980, 3). The three ideas of electricity, magneticism and light are united in an overarching theory (Beeson and Mayer 2008, 77). Heinrich Hertz strengthened the theory by experiments which indicated electric circuit-generated electromagnetic waves conformed to the same physical laws that lights or optical waves did (Brill 1980, 3). Light, therefore, exhibited wave properties and its nature was electromagnetic. Clegg describes the process as that in which "[l]ight was the result of the two at just the right speed as a ripple of electricity that supported a ripple of magneticism that supported the ripple of electricity." (Clegg 2001, 167).

But very early in the 20th century it was found that some properties of light could not be explained by the electromagnetic theory. For example, the theory could not explain a blackbody's radiation (radiation absorbing material across the spectrum of the wavelengths) (Bloembergen 1985, 656; Murdoch 1985, 14). The explanation could only come from a particle (corpuscule) theory of light. Isaac Newton had suggested a particle theory of light but that had been dis-regarded with the advent of the electromagnetic theory of light (Brill 1980, 3; Ditchburn 1976, 13, Murdoch 1985, 14).

A key element in understanding the workings of light is to be found in the work of Max Planck on black-body radi-ations. Those entities, though without color and non-reflect-ing, glowed more visibly as their temperature increased: temperatures change resulted in color changes. Ongoing thermal activity throughout the electromagnetic spectrum range appeared to be taking place. Scientists were aware that energy exchange was taking place in the black bodies. Greater temperatures added energy in a heat form. Energy was removed by light radiation. The color of the emission and intensity of it were brought about by the wavelength or light frequency (Mooney 1996, 73-74).

Planck noted that, according to classical physics principles, the energy additions and subtractions should be a continuous process. However, the theory did not match the colors observed, and changes in color. Planck came to the conclusion that theory and observation could only agree if the light energy was emitted in the form of very small bundles whose "propagation [was] perforated by "jumps." (Mooney 1996, 73-74). Planck referred to energy granules as quantas. Quantas contained varying amounts of energy frequency. A high frequency wave (with short wave length) contained more energy quanta radiation than a low frequency one. Planck developed a way to measure wave energy. (Mooney 1996, 73-74).

This way of measurement, Planck's Constant -- which is at the heart of Quantum Theory -- indicates "that the energy *E* of emitted radiation is proportional to its frequency *v* according to the following equation, where *h* is a constant ... ." (Brill 1980, 3). This hypothesis does not insist that emitted energy must be in packets. A possible but difficult, reconciliation with wave theory cannot be ruled out. In 1905 Albert Einstein, who made use of Planck's work, perceived that light "was in the form of small energy 'quanta' " (later termed photons) (Brill 1980, 3). The work of other researchers coupled with previous work brought about the Quantum Mechanics theory by 1927. The existence of that theory does not resolve all of the problems regarding an understanding of light.

There are several possible and revised explanations of light. One theory of light combines Maxwell's electromagnetic theory with Einstein's notions of photons and relativity. Each partially approached the workings of light. (Brill 1980, 3-4). A variant version notes there is no theory of light in itself. Rather, Quantum Mechanics is one theory that includes light properties and matter properties. This version (Ditchburn 1976, 13-15) can be placed in a diagram form showing "streams" of electromagnetic theory, quantum theory/photons, and relatively flowing into and forming Quantum Mechanics. Ditchburn notes that in Quantum Mechanics the two ideas complement rather than rival each other; each notion has appropriate milieux. Bloembergen speaks of properties of light which are "wave-like" and other properties which are "particle-like" and the manner of their combination in Quantum Mechanics "without internal contradiction" (Bloembergen 1985, 656).

A leading illumination engineer offers yet another explanation by suggesting light has a dualistic nature (Murdoch 1985, 17). Murdoch notes that quantum theory (rather than the term Quantum Mechanics) offers a better explanation of some parts of the processes of energy transmission than the older electromagnetic theory. While the older theory better explains the remainder of the process than the newer thought. Dualism, in this view, more adequately describes the process than a single element. Dualism, in this view, more adequately describes the process than the newer thought. Dualism may suggests a two-track form that manifests a closely united nature of two elements rather than two tracks combined into one.

Yet Harald Fritsch (of the Max Planck Institute) states that Maxwell's electromagnetic theory is intact. The theory may be intact but it needs to be interpreted: all waves are in photo form. While there may be no contradiction between the view of Fritsch and other authors, yet Fritsch's interpretation seems at variance with the idea of combining disparate elements, and of separate thories that explain some though not all light processes. It may be enough to say that either the once-dominant electromagnetic theory of light has become subsumed into a more all-encompassing theory which more adequately explains light, or the electromagnetic theory remains valid but needs to be interpreted in the light of the photon theory (Fritsch 1984, 105-106). Daly notes that "Niels Bohr showed that light could be understood and treated as either wave- like or particle-like, but not at the same time, and that each function complemented the other." (Daly 1989, 16).

Put simply, light is radiant energy. A more expansive definition is offered by Murdoch: Light is "visually evaluated radiant energy." Light is "transmitted by radiation, and ... a form of radiant energy to which the eye is sensitive." (Murdoch 1985, 5). Light occupies a portion of the electro-magnetic spectrum that includes energy in a variety of wave-lengths including radio, cosmic and x-rays. The wave-lengths that are visible to the unaided eye are termed light (Danger 1987, 36). The next segment examines the meaning of color.

2A2 Introduction to Color

And what is color? The sensations generated by specific wavelengths in this visible part of the spectrum. Kaufman completes this definition by noting colors are the "characteristics ... by which an observer may distinguish between patches of light of the same size, shape and structure." (Kaufman 1981, 5-2). Wikipedia offers a variant description: "Color derives from the spectrum of light (distribution of light power vs wavelength) interacting in the eye with the spectral sensitivities of the light receptors." (Wikipedia. Light. 2013).

The visible part of the spectrum is one color: white (Danger 1987, 36). If light is "broken down" through the use of a prism six colors appear: the primary ones of violet, blue, green, yellow, orange and red. Red is the longest in wave-length while violet is the shortest. Visible light is bracketed by infrared rays (just above) and by x-rays (just below violet). (Danger 1987, 36).

The wavelengths for primary colors are:

380-430 nm Violet
430-490 nm Blue
490-560 nm Green
560-590 nm Yellow
590-630 nm Orange
630-770 nm Red

(nm=nanometers. These are sometimes referred to as millimicrons; a millimicron is 1/1, 000, 000 of a millimeter; ten millimeters= .03937 inches) Murdoch 1985, 10). Cutler (1972, 13) has figures somewhat at variance with other sources: 400-450 nm violet; 450-00 nm blue; 500-570 nm green; 570-590 nm yellow; 590-620 nm orange; 620- 700 red.

Human vision and the presence of color is a complex process. A color sensation is generated when light (radiant energy) passes into the eye (Danger 1987, 36-37). The human eye has three forms of receptors: one responsive to red, another to blue, another to green. The light that has entered the eye acts as a stimulus for the receptors which creates nerve impulses in the receptors which, after transmission to the brain, become mental images. (Danger 1987, 36-37).

Equal stimulation of the receptors results in the brain perceiving white but the receptors need not be so stimulated. If, for example, the blue receptor is not involved then the receptors for red and green create yellow. The degree of involvement for the receptor means that a vast number of permutations is possible. White, black and gray supplement the six primary colors in this process. Yet an older essay (Hartridge 1961, 102-111) questions the three-color theory and insteads promotes a seven receptor, polychromatic theory. The second theory contains tricolor receptors and two subsidiary units (Y-B and R-BG-Y). The more complex theory may have much to recommend it over the simpler one. Yet the three-color receptor theory is buttressed by the more recent work of Davson, *The Physiology of the Eye* (1990, 399-400).

There are many physical, physiological, and psychological factors that affect the creation, transmissions and interpretation of color. These include the light energy, absorption, reflection and transmission of the energy form that the human eye receives and which it processes as well as the viewing conditions (Culow 1972, 35). Culow notes that "colour, as such, has no <u>material</u> existence. The wavelength of the light is the physical reality (the stimulus) which is responsible for the perception of colour. For instance, a light beam of wavelength about 550 nm is not in itself green but the reaction caused by it on the eyes of a normal person is that which we call green." (Culow 1972, 7). The remark that a wavelength is not a given color but rather what humans so regard as color as energy processed by the eye and brain is an important observation.

What are termed primary colors depends on the perspective in question. Chemistry views color as a matter of pigments and compounds; primary colors are red, yellow, and blue in this perspective (Birren 1963, 84, 98, 141-151). Physics views colors as light and includes red, green, and blue-green. Physiology and psychology, which examines color from the perspective of human vision, includes four primary colors: red, yellow, blue, and green according to Faber Birren. Earlier studies held to the view there were three primary colors and these colors correspond to the chemistry or physics perspective. More modern studies (including Herring, Ostwald, Hofler, Birren) found that what humans view in color differs from color as pigment or light and therefore colors are primary for humans. (Birren in the places cited).

Possibly the best known figure for color research in the US is Albert Munsell (Birren 1963, 144-151). His studies incorporate a strongly physics-orientated approach to color. Munsell followed Helmholtz's notion of color having three facets hue, value, and intensity. Hue refers to that quality which the non-specialist terms color. Value has reference to brightness (the dark or light of a color). While intensity, or chroma, focusses on the purity or grayness of color. (Birren 1963, 144-151).

Munsell emphasized the physics of light but he also included the psychology of color through his representation of some hues as stronger than others in his color solid. (See *Science of Color,* 1953, 367 for a discussion of color solids). Munsell occupied a middle ground "between color as energy and color as sensations." However, Birren notes that Munsell's work fell "short of the kind of perfection realized by Wilhelm Ostwald." (Birren 1963, 144-51).

Ostwald notes that the science of color has occupied one of three perspectives: chemistry, physics, or physiology/psychology. Ostwald, after a review of other studies, thought that "in the last analysis color is a sensation" and that a "true solution of color's mysteries lay in an analysis of the physiological and psychological processes of seeing." (Birren 1963, 144-51).

Ostwald adopted Herring's four primary color system of red, yellow, green, and blue. But he constructed a new pattern of color based on three colors. Herring had also advanced the idea of color having three forms: pure hues, white, and black. Ostwald's system of color has seven forms of color: a) the first form includes the pure hues of red, green, yellow and blue; b) the second is that of white; c) the third of black; d)-g) the final forms are mixtures of the first three. Human vision perceives only these forms. (Birren 1963, 144-151).

Signal colors have been greatly influenced by early work in color. Primary colors mirrors developments in T-M. It can be noted that in T-M the definition of primary colors may vary with the mode-specific context, and color is not the only factor at work in T-M forms.

2A3 Light Sources

Incandescent light globes have had a major role in electric safety aids though a few aids have employed other lighting forms in the past (e.g. some early approach lights employed neon; see Part J, 90). In recent years other forms of "bulbs" are increasingly employed. These include halogen, metal halide, discharge forms. More recently an additional form, L.E.D. (light emitting diodes) has achieved a prominent and may supplant traditional and less than traditional forms. (Electric Light 2012)

The incandescent bulb dates back to the 1870s (Joseph Swan and Thomas Edison are the inventors). In incandescent light an electrical current passes through a wire (often tungsten). The wire glows and light energy radiates outward. However, most of the energy is in a heat form not light (Electric Lighting Comes of Age 2002). One source claims only 5% of the energy is light while a second suggests 15%. (Light Emitting Diodes, Carmanah 2003; Laughton 1985, 27/8). The incandescent bulb can be made more efficient but that results in a shortened life span. (Laughton 1985, 27/8).

Halogen lamps (that is one of many names for this light source; other names include halogen cycle, tungsten-halogen, quartz, quartz-iodine). (Glossary of Light 2004). These are incandescent lamps that employ a halogen group gas such as iodine or bromine (Glossary 2004). With the presence of iodine any tungsten evaporating from the filiament will be regenerated and return to the filament. The cleaning or regeneration process adds to the life span of the lamp.

(Technical Information 2004). Halogen lamps experience a reduced level of darkening of the globe in contrast to conventional incandescent bulbs (Lindsey 1991, 43-44). Halogen lamps very "color rendering." And they produce considerable wattage in a small envelope. (Lindsey 1991, 75). Many areo nav lights employ halogen lamps (e.g. ADB 1991).

Flashing lights have long been a mainstay of aviation safety. (see Part J). Historically these have been largely of an incandescent form. A different form of flashing light developed in the last half- century. These lights are known by many names including strobe lights, capacitor-discharge, and condenser-discharge lights. These were originally employed for approach lighting and more recently for obstruction lighting (see T-M Studies: Part G and Part J). While discharge light forms have differences they share a xenon short-arc technology. The arc tube is comprised of a tube or envelope of quartz containing xenon gas in which an electric current travels through the gas between two electrodes. (*IES* 1984, 8-52, (Kaufman); Brooks 1983, 255). The flash tube can be either compact or linear in form. The color has been described as that of daylight or sunlight. (Technical Information 2004). The energy for the flash comes from energy stored in a capacitor (Brooks 1983, 268).

The metal halide lamp is a form of discharge lighting; that is of high intensity discharge nature (mecury vapor and high pressure soldium are of that form) (Brooks 1983, 236-37; Glossary 2004). Metal halide lamps include a ballast that allows the light to continue operation in contrast to short-arc of xenon lights. Metal halide lamps includes traces of metal that creates a white light of a daylight character. Metal halide lamps are long-lasting and efficient. A variety of aero beacons employ this technology. (The Metal Halide Story; Wood, Mike). Metal halide can be viewed as a possible replacement for incandescent lights. (Keeler 1987, 291). However, the Coast Guard has instead employed L.E.D. forms. (see LNMs of 13th CG District, 2003-04).

L.E.D. (light emitting diodes) have rapidly become a key form of light. Marine aids to navigation, traffic signals, railway signals are adopting this form of lighting. The L.E.D. is a tiny silicon chip requiring only an electrical current of limited power. An L.E.D. emission consists of one wave-length that is of a specific form. Earlier L.E.D.s were of long wave lengths. Red LEDs, for example, became available in 1960s. Shorter wavelengths were more recent. The three primary colors are in use. (Beeson and Mayer 2008, 86). Each chip is composed of crystal elements for one color. Filters are not needed. Electrical energy is converted to light not heat in contrast to incandescent lamps. Solar energy is often used for L.E.D. modules since the diodes are of low voltage and suitable for that energy source. The life span of the diode can be measured in years rather than in hours. Many diodes are needed for a single installation. Even hundreds of L.E.D. modules at an installation (e.g. a traffic signal) require little energy. (Light-emitting Diodes, Wikipedia 2004; Carmanah: Light Emitting Diodes; Light Emitting Diodes-MRSEC.wisc.edu 2001).

An older light source, neon, finds some use for obstruction lighting. Seemingly this is more frequent practice in Europe. ICAO speaks of a cold cathode neon-filled lamp that can be directly attached to power lines and from which it draws its energy. The neon red is reasonably close to signal red. A neon discharge lamp set within a vertical tube is marketed by ADB and other European firms as a low-cost obstruction aid. Some limited use of mercury and flourescent lamps are also employed for obstruction lighting. (T-M Studies: Part G; ICAO 1993, 128; manufacturers include ADB 1991, Cegelec 1992, and Thorn Europhane 1992).

2B Color & Transportation-Markings

2B1 Historical Development of Color Use in T-M

A survey of the development of color usage for T-M usage examines several issues: a) color usages that pre-date T-M and therefore come from other fields; b) color usages that originate in scientific and technical disciplines or: c) color usages emanating from T-M forms.

A historical survey of color messages for T-M soon encounters a problem in examining possible pre-T-M messages. Henry Dreyfuss notes in his *Symbol Sourcebook*, not a “single source ... explained the traditional and contemporary meanings of specific colors in specific contexts” (Dreyfuss, 1972, 232). Historical sources that consider color meanings often do so only in general terms. However, some evidence is available that may indicate messages which correspond to T-M messages and may predate that usage.

Dreyfuss notes that for the 200 years before 1900 only red had a meaning corresponding to present signal usage (Dreyfuss 1972, 238). Red has had a variety of meanings including that of danger. Red flags were employed in colonial Massachusetts as a signal to a doctor while he was on his rounds; storm warning flags were also red (Dreyfuss 1972, 238-239). These examples suggest red had a danger or near-danger meaning before the advent of modern T-M forms. But a reviews of Dreyfuss found no evidence that yellow or green may be employed in modern usages. There are indications of the use of yellow and green in industrial safety and auto racing but only after T-M usage was underway (Dreyfuss 1972, 240-241).

Green and red were employed as markers for starboard and port side (respectively) of ships, beginning in 1847 which may suggest the use of green and red in Eastern Hemisphere buoyage and beaconage markings (O'Dea 1959, 68). However, red was employed for starboard buoys before that date and not until the early 20th century did some nations employ a pattern based on the 1847 shipboard lighting practice. (Naish 1985, 194; Parts C/D, 2010). Admittedly, the marine use of green and red is at variance with the core meaning (red=danger, stop; green=proceed, clear) whether red is to starboard or port, and green is to starboard or port.

While the evidence is limited and sketchy for T-M message patterns there are indications that red came from non-transportation uses (green and red in marine T-M forms are a variant usage). But for the most part, T-M color formulae emanated from other sources. Other possible sources of color meanings include color studies in psychology, physics and chemistry, and the internal requirements of T-M.

Much of the work in color standards for T-M took place in the late 19th and early 20th centuries. Psychology was in its earliest stages during this time and not a major factor in the development of color messages; it becomes a major factor in color and in T-M messages but only after many of the foundations were established. Color studies based on physical science were of more significance.

T-M message colors are similar to primary colors which may suggest an influence from color studies. Some of the major work in color studies took place at about the same time as did developments in T-M color usage. Close parallels between the work of Munsell and Ostwald indicate an influence upon T-M developments. Especially important is the Munsell color system since it fits well with signal color systems especially those of railways. International Commission on Illumination provides a historical summary of color in transportation and of their work in creating standards (CIE 1975).

Munsell’s hues include red, green, yellow, blue and purple (Birren 1963, 148-149). All separate developments in the lab and on the railways may indicate mutual influence. It may have significance that Munsell includes purple unlike othere systems; purple appears in railway color patterns though on a limited scale. The role of scientists in railway color systems late in the 19th century and early 20th century can be noted (see Ch. 2C). CIE 1975 also notes the combination of practical railway work and laboratory investigations (page 5).

Munsell's studies were less vision-orientated than those of Ostwald yet they had greater impact on color. This may suggest that Munsell's work took place about the same time that extensive transportation color usage was developing. It does not necessarily indicate the superiority of Munsell over Ostwald.

The use of primary colors in T-M may possibly have been selected because "red, yellow, green, and blue are unique in appearance and resemble nothing else" (Birren 1963, 151). The use of primary colors needs to be qualified since some special hues have been employed that are outside the range of primary colors (e.g. lunar-white, and what one railway calls orange [though that may be within the limits of yellow]) (Swiss Federal Railways 1981; Part F, 1991, 117).

Color usage in T-M is not entirely an achievement of science. Some measure of historical accident and even arbitrary actions played a role in these developments. Lighthouse authorities as well as railway companies made use of the available color glass technology and mechanisms of their times. And science and technology were not always the final arbiter in these matters. The colors employed and the resulting messages were formed by the agencies and companies directly involved in signals with a complementary yet increasingly important role by scientists, engineers and technicians in manufacturing concerns, government agencies and universities.

In summary, the meaning of most signal colors does not predate the modern era of T-M. While psychological factors are often important in scientific color studies it is not responsible for very much of the actual T-M color usages. The development of the T-M message system was brought about by an interplay of the signal system with the science and technology of the late 19th and early 20th centuries. The work of chemistry and physics, especially in railway signal undertakings, greatly influenced the development of the colors employed and the accompanying messages.

The focus of this segment has been on color meaning to T-M. It can also be noted that over many decades certain colors have meanings stemming from T-M. Colors can also be removed from T-M usage and retain the same meaning in diverse roles. For example, to say that an arms control agreement has received a yellow light means that caution has yellow light means that caution has crept into the process or even that the agreement is on hold. Red with the meaning of danger or stop occurs in advertising and the same is true of green with a meaning of "go ahead" or "pull out all the stops." Many of the meanings associated with colors used in T-M do not preceed those selfsame markings yet many of those meanings follow meanings created in T-M usage.

2B2 Summary of Color Usage in T-M

The limited scope of this monograph cannot encompass the full range of T-M messages; however, a general review of color uses in T-M is feasible. The first edition of Part A color usage was arranged by the transportation mode (aero, marine, rail, road). But in the 2nd and 3rd editions (1991, 1999) the focus was on the color usage followed by reference to the mode. The modal monographs provide more detailed coverage. Color usage is not fully accompanied by references in this study since the coverage ranges over a broad spectrum of materials. However, the several modal monographs supply that information.

The use of red follows the widely-accepted meaning of stop in many cases. In aero markings it finds frequent use in obstruction markings on towers, buildings and other barriers that can affect air navigation. Red is not infrequently combined with other colors. For example, red is added to the backside of aero threshold lights to denote wrong direction by aircraft (T-M Studies Iiv 2009, 173). It also conjoined with the color white in aero approach lights (T-M Studies G 1994, 89).

Red can be employed with variant meanings that do not necessarily denote danger. In marine aids to navigation red alternates with green as an indicator of the sides of channels rather than serve as a stop signal (T-M Studies C-D 2010, 103). Red is infrequently used as a danger signal in marine navigation. A limited number of lights may have a red sector (T-M Studies, 143) that denotes an area of danger near the light. That usage could constitute a standard meaning. Red is also found with directional lights (narrowly focussed lights of several colors delineating multiple channels) (T-M Studies, 143). Seemingly, no other transportation mode employs a principal color in an atypical usage to this extent.

Red has the accepted meaning of stop in road and rail situations; most of the use of red as a stop or danger message originates with these signals. A possible area of confusion is the railway use of red when conjoined with other colors (T-M Studies F 1991, 93ff). The use of multiple colors indicates qualified versions of more basic messages, or -- in the case of multiple-signals heads -- red can have the standard meaning even with other colors present. Traffic signals are an exercise in simplicity in which red has an unvarying message of stop (T-M Studies E 2004, 98ff). There are a limited number of situations wherein a flashing red or double red indication is present and these represent additional variants of the basic stop message.

Green was once a cautionary color for railway signals, but it has become associated with a "go" message. However; an exception is found in marine usage. It has a somewhat limited role in aero navigation though various aero beacons employ green, the "go" side of threshold lights are green in color; taxiway centerline lights represent a variant use (T-M Studies G 2004, 118ff).

In marine aids to navigation green shares the function of marking the sides of channels with red. A point of confus-ion concerns the determination of which side is concern the the determination of which side is marked by green and red. In most instances the Eastern Hemisphere employs red to port and the Western Hemisphere red is to starboard (this matter is further complicated by the direction of the head of navigation). (T-M Studies C/D 2010, 39ff).

Green in rail and road signals follows the format of the comments about red. The basic meaning ascribed to green comes from those signals. Green in rail use may appear by itself though it can appear with other colors which in some instances can qualify the basic message. Flashing and multiple green railroad signals signify other meanings (T-M Studies F 1991, 135ff). The use of green for road signals follows a simple pattern with few qualifications (e.g. turn and lane signals).

Yellow has a widely agreed-upon meaning of caution. A variety of terms in addition to the word caution have been applied to yellow. This is especially the case with railway signals. Yellow is found with some forms of airport beacons both alone and in conjunction with white. Yellow is employed for portions of runway edge lighting. Yellow in the previously described situation may have a cautionary character since yellow/white edge lamps are located between approach lighting and the main section of edge lighting (T-M Studies G 1994, 107). Yellow has a limited role in marine navigation. These uses include special purpose buoys and warnings.

Yellow is part of a triumvirate of basic colors along with red and green. Yellow has an importance in road and rail approximating that of red and green. Road signals employ yellow for cautionary messages (T-M Studies E 2004, 98ff). Rail signals have a more complex pattern of usage which include yellow as well as red/green messages that represent several forms of cautionary messages (T-M. Studies F 1991, 93ff).

Red/Green/Yellow represents a large range of colors and meanings for safety concerns. Yet white is a frequently employed color and in some instances it may be a more commonly used color. White is the most common color in use at airports and it is also significant away from airports. White finds use with beacons, approach lighting systems, runway edge and runway centerline fixtures. White is sometimes used alone and with other colors at other times. (T-M Studies G 1994, 89ff).

White is also a key color in marine color usage. Most major coastal lights employ white, and white is used for many other lights as well. It is also employed in buoyage systems for specified roles. White and other colors in marine use are configured by formulations tailored to individual installations which expands the range of light phase characteristics. The new international buoyage system has decreased the use of white since the new system is more specific about color usage than previous systems which results in increased use of green and red. (T-M Studies C/D 2010, 79ff, 136ff).

Road signals colors do not include white. But many road pavement markings employ white as well as some signs. White is also used for railway signals though on a more restricted level. Some mainline signals display white messages though often for specialized purposes (e.g. switch/point indicators). (T-M Studies E 2004, 122ff, 147ff, 158ff).

There are also some special forms of white in use. One such form is lunar white (sometimes termed blue white) used by some railways. A second form termed “variable source white” is employed largely with aero lights that can vary intensity according to weather conditions and the time of day. Changes in intensity alter color temperatures and hue of the color in use. (Breckenridge 1967, 48; see also ICAO 1990, Attachment A).

The other colors in T-M are more restricted in use. Blue is the most important among these colors. It is used for taxiway light at airports, construction work, and derails on railways. Blue also find limited use with road signs and pavement markings T-M Studies E 2004, 106ff, 122ff, 147, 162). Purple (often termed violet in Europe) has limited applications in railways. It has been a substitute for red in some non-mainline signal situations. Amber is not a color in itself but an alternate name for the yellow hue of yellow but remains within the spectrum of tolerances for yellow. the color orange employed by the Swiss Railways is also within acceptable yellow boundaries (T-M Studies F 1991, 109ff). Orange in different hues than previously described forms are employed for some buoys and some older pedestrian signals. Some aero markings also utilize orange. Other colors include black and brown which are sometimes employed with road signs.

The welter of colors and meanings can become confusing. But the core colors of red/green/yellow with the accompanying messages of stop/proceed/caution constitute much of the color system in T-M. Marine and aero aids aids to navigation represent a kind of sub-culture of usage. White occupies an intermediate position with major uses for marine and aero aids. The remaining colors are much more restricted and peripheral in T-M usage.

2C Historical Development of Color Messages In the Nineteenth and Twentieth Centuries

1 The Development of Messages, 1800-1920

a) Prelude to Chapter 2C

Developments in T-M forms took place over a long span of time. The beginnings of some events in T-M can be determined clearly while many other events are often uncertain even within a chronological structure. Two attempts at categories and time periods have been attempted in thise studies. The oldest chronology comes from an early monograph (1977) and was retained despite its inadequacy. A newer and more adequate historical framework is found in *T-M Historical Survey.* That approach has been applied to this edition and outlined in the following paragraph.

Older editions of *Foundations* (1981-2008 and "prehistory" writings in the 1970s) developed a chronology for T-M that appeared to be workable for diverse safety aids: Before 1900 was divided into Before 1850 and 1850-1900, and Since 1900 divided into 1900-1925 and Since 1925. That has proven to be inadequate and not entirely accurate. The *T-M Historical Survey* (2002) pursued a different approach: periods of time that include boundaries for all categories, accompanied by more accurate historical divisions: 1750-1920 divided into 1750-1870 and 1870-1920, and 1920-2000 without divisions. *T-M Historical Survey* also includes a survey of pre-1750 safety aids for marine and road forms. This edition of *Foundations* follows a modified version of the latter work: 1800-1920 divided into 1800-70, 1870-1920, and 1920-2000. Marine and road aids may stray into the 18th century, and the 1920-2000 era may have only limited coverage in the late 20th century.

The coverage of *Foundation* editions is largely centered on lighted forms (and forms that incorporate unlighted and lighted dimensions). Color, light and messages are the primary concern of the study. References to unlighted aids are limited though the color codes for lighted forms often encompass other forms. Attention to physical apparatus is limited save for its direct integration with color and light.

b) Safety Aids, 1800-1870

It is obvious that T-M before 1920, and even more before 1870, displays a truncated appearance. The aero mode did not exist and traffic signals were a rarity before 1870. The remaining modes were served by markings of a relatively complex nature. In the early 19th century only marine marking systems were somewhat substantial. Traffic signals were limited in scope and of a simple nature. Railway signals were in an embryonic stage though growing and becoming complex gradually. However, developments in color messages in one or two modes spilled over into other modes and in time affected the full spectrum of T-M. To speak of color developments, for example, on the coast of England and Scotland may seem a narrow topic yet it could have far-reaching results. That is also true of many other seemingly small events in color.

At the beginning of the 19th century marine markings stood nearly alone as a T-M system. A single color, white, was pre-eminent in that system. Though the range of that color was not as narrow as that statement might suggest. “White” can include a number of hues; the phrase “uncolored light” includes shades known as “white, bright, or clear” (Stevenson 1959, 77). The color of illumination, when colored glass is not employed, can also create a difference in color.

This is especially the case when a variety of fuels were employed to produce early lights.

Despite the primitive state of early 19th century technology, including that of glass manufacturing, some marine lights exhibited color messages. For example, Flamborough Head had a red and white color system in 1806 and it also revolved. This may be the first light exhibit a two-color message, as well as revolve. Bell Rock (or Inchcape) displayed large panels of red glass after Flamborough was established. Extensive use of red glass was probably a rarity then and later. (Stevenson 1959, 77).

Some color studies were underway in the early 19th century. For example, A.D. Stevenson carried out experiments that demonstrated “red was the best color as an alternative to white or natural light” (Stevenson 1959, 79); that finding is borne out by much later studies. A French contemporary of Stevenson, Baron Saint Holouen, proposed a color light system for distinguishing between lighthouses but that proposal did not reach a concrete stage. (Stevenson 1959, 79).

A US lighthouse in New Hampshire displayed a three-color message of red, white, and blue. This may have been more of a patriotic gesture than an advanced color optic system. The blue was soon dropped because it could not be seen for an adequate distance (Adamson 1953, 88). Blue, in time, would continue to find other uses in aero usage, limited employment in railway signals and non-lighted uses for roads.

Perhaps surprizingly, the first light in England with a color message displayed a green light not one of red. Green had a shorter viewing capability in comparison with red and was rarely employed for coastal lights. That initial color light, the Smalls in UK, was an early light: 1775. (Stevenson 1959, 281-282).

Color developments were very gradual but there were more extensive changes in light phases characteristics. In 1750 all lights had been fixed but by 1800 three additional characteristics had been added: revolving, oscillating, and occulting. Quick-flashing was added in 1819 and additional patterns were added late in the 19th century and in this century. (Stevenson 1959, 281-282).

By mid-century the situation in lighthouse forms was not greatly different from half a century earlier. Lights were usually dim in intensity, often white in color and not infrequently of a fixed character. The later years in the 19th centry saw many more developments in light phase characteristics, lens optics, and improved illuminants. (Stevenson 1959, 281-282).

The first established traffic signal was operational in London in 1868. The signal, produced by a railway signal manufacturer, consisted of lamps and semaphore arms. That signal blew up causing death and injuries. It displayed red and green colors for a two-indication message with red indicating danger and green denoting proceed (O'Dea 1958, 80-81, Mueller 1969, 6-7). Those messages are at variance with railway signals which indicated danger and caution. The signal may have served as a pedestrian crossing signal (Lay 1990, Vol I, 32).

A much older version of road signals also existed. This "land lighthouse" was similar to a marine lighthouse in that it was made up of a tower topped by an open fire. It was not intended to direct or separate traffic but rather to provide guidance for travellers between towns (Stevenson 1959, 47). A simpler "land lighthouse" was established near Whitby in Yorkshire in the early Middle Ages. This writer has a photograph of that beacon which shows an iron brazier fastened to four wooden poles, the purpose was identical to the more elaborate land tower. The great tower of St. Botulph's Church in Boston, UK may constitute a third example of a "land lighthouse." Knowles refers to it as the "beacon of the fens." (Knowles 1976, 14).

Railways began employing simple signals in England early in the 19th century; developments were later in the US. The first signals may have been on the Liverpool & Manchester Railway in the 1830s. One version of the model from 1834 underwent an altered version in 1838. It displayed a full vane as a danger signal and red lamp. A half-vane indicated safety and the lamp was white. A second signal displayed red, blue and white indications. The color blue was in a paint form only (Calvert 2004, 6). Early signals were often similar to current switch signals with targets. An early US signal form utilized flags, baskets or balls painted white or black. White was the clear indication of that time and for many years to come; black represented a hazardous or stop condition. A somewhat more modern signal employed discs painted white or red. White continued as a clear or go signal while red became the symbol of danger; the red discs contained the word "danger" as well. When night messages were added they followed the white and red pattern of day indications; the “banner” box signal of the Civil War era continued that message pattern. (ARSPAPOS 1953, 5-11, 15-17).

The first UK semaphore was that of the London and Croydon in 1841; a second UK railway, South Eastern and London and Brighton also employed semaphores in 1841. The lights were in red, green and white. Semaphore arms indicated the same messages with the go position consisting of the arm vanishing into the signal post. (Simmons 1986, 192).

Chappe Brothers, a French firm, determined that the colors of red, white, and green were more commonly used on railways than any other colors, and also manifested a stronger intensity. Through survey and experimentation they also found that white was the most frequently employed color and of the strongest intensity. White thereby became the proceed indication. Green became the caution signal in the Chappe study.There was no adequate yellow. Blue and purple had limited visibile. (Calvert 2004, 7)

White signals became a major safety problem within a relatively short time after the 1841 Conference. It was found that if a red or green lens broke or fell out of the signal then the lamp became a de facto white signal indication. Or if a house lantern near a track displaced a strong white light that lantern might be mistaken for a signal message. In the British Isles the task of phasing out the white signals was soon undertaken. White lasted far longer in the US. At least one US railway dropped white because of an accident and instituted the now familiar green/yellow/red message pattern. (ARPSPAPO 1953, 73).

Mashour offers an "incomplete precis," or thumb-nail sketch of railway signals, from the 1840s until late in that century: "The first fixed signals appeared in the late thirties of the last century, consisting of posts with a pivoted flag or board in daytime and replaced by a lamp at night. Thereafter, disc-and-crossbar, or revolving boards of one shape or another, pivoted boards with a half-moon cutout, disc signals, semaphores, etc. were introduced. Semaphores were soon fitted with lamps, showing red, green and white lights at night, indicating 'stop', 'caution' and 'clear' respectively." (Mashour 1974, 22).

By mid-nineteenth century T-M forms and their message systems were limited in numbers and in complexity but some advances were occuring. Marine colors and light phase characteristics had undergone some improvements and expansion. For example, lighthouse technology (including the Fresnel lens and improved fuels) was experiencing major developments. Railway signals employed several colors. Red was in use and displaying the meaning it has at present. White was a significant color indicating proceed. That is a different meaning than the present meaning(s). Green had limited use during the mid-19th century. It had begun as a caution color and long retained that meaning especially in the US. Modern T-M forms and messages were some distance in the future. However, some embryonic underpinnings were becoming visible by mid-century.

c) 1870-1920

The years of latter 19th century are a vital transition period for T-M. It is the last period without aero navigation aids. It also includes the most intense period of the crisis in railway signal color development. The same era represents the zenith of visual marine aids to navigation, and it includes the first modern traffic signals. It is a period of embryonic beginnings more than a type of fully completed solutions. The railway signal problem is not resolved until late 19th/ early 20th centuries nor do seminal changes occur in marine aids until the 20th century. But that half-century is, none-theless, a vital bridge between a more primitive level of markings to a level more closely resembling modern T-M.

Throughout much of this period the railway signal color pattern remained relatively uniform: red for stop, green pattern remained relatively uniform: red for stop, green for caution, white for proceed (ARSPAPOS 1953, 73-74). The original code (formulated at Liverpool before the mid-point of the century) had far reaching impact. This is not surprizing since railways were largely confined to the industrial nations of Europe, Japan, and North America; signal work in the UK had a significant impact on that restricted railway network.

The slowness for changing colors and messages can be traced to at least two explanations: a) human inertia: the railways were accustomed to the older system and may have perceived a potential for accidents if the existing pattern was changed. The railway attitude may have been less ingrained in human consciousness and more of a conservative attitude. b) The second explanation for the slowness of change was the unsolved problems of precise color definitions at that time, and the low quality standards for signal glass. Until those problems could be resolved it was not possible to say what the characteristics of any color ought to be and also impossible to produce glass of uniform hues.

The use of the color white in the 1840s was a workable hue but less so in the 1870s. In the view of Vanns there were many more "nocturnal lights" in the later 19th century. This added to the current problem if a red lens fell out of the lamp it thereby created a white light with the reverse meaning. 3-position Semaphores were in decline in UK in the 1870s. 2-position signals allowed green to become a proceed indication. (Vanns 1997, 33). In 1893 the "Railway Clearing House" (UK) it recommended the ending of the use of white for clear indications. (Vanns 1997, 33). US was as slow as European railways in replacing white with green. That may be true of continental European rail lines but UK made the change years before it became common in the US (Allen 1982, 149).
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The first use of yellow as a caution indication was apparently in 1899 on the New York, New Haven & Hartford Railroad (Am Eng & RR Jrnl 1899, 124-125). Green thereby became the clear or proceed indication. But lacking consistent and clear standards the problem continued (ARSPAPOS 1953, 73-75). An optical lab at Corning Glass Works undertook the task of creating clear and precise color standards. The Railway Signal Association was closely involved in these efforts. Finally in 1908 recommendations on colors and uses were made and passed by RSA. Standards included red, yellow, green, blue, purple, lunar white. The end result were multiple colors with clear boundaries and yellow as a safe and reliable cautionary color (ARSPAPOS 1953, 74-75).

Before a permanent solution was to be found to the problem there were interim solutions. One attempt at a caution signal employed a red and green signal together. Red alone or green alone gave a standard meaning but together they would signify a cautionary message. A second alternative proposed a system of position and light signals for caution. This was introduced and continues on some railways. (ARSPAPO 1953, 74)

Late in the century the American Railway Association continued the hunt for a third color for a caution signals continued to be elusive (ARSPAPO 1953, 74). Several colors were suggested for a caution signal including violet, blue and orange. Violet was presumed too close in red in the color spectrum to give a clear and unambiguous message. Blue and orange were also proposed. But again the possible or even likelihood or confusion with other colors precluded their use. The red/green combination idea was implemented on some railways in the face of no workable alternative. Late in the century a decision was reached approving green as the proceed indication but this remained an abstract resolution for some time. (ARSPAPO 1953, 74).

The problem of deciding colors and messages could not be resolved before the science and technology undergirding colors and messages was resolved. A remarkable range of hues were masquerading under a few basic names: reds ranged from orange to deep red, greens might be yellow-chrome, blue or any point in-between. Yellows, blues and purples suffered from similar vagaries. These problems explain why yellow could not be a caution indication; some yellows were reddish-yellow and could possibly be confused with red, while other yellows were greenish-yellow and possibly confused with green. One problem was moving toward resolution: green gained acceptance, including in the US, as the proceed indication. Only gradually did clear indications of the shape of modern T-M forms develop. Changes began with hazy outlines of how safety aids should function and changes in color and light phase characteristics were joined by advances in lighting illuminants, optical apparatus and mechanical equipment. (ARSPAPOS 1953, 74).

Green and red were rarely used in the first half of the 19th century and for much of the second half as well. A group-flashing light phase characteristics was added as well as a form of pre- Morse code indication (flashes indicated agreed-upon numbers rather than letters). A quick-flashing characteristic also joined the list characteristics. The existence of more characteristics does not mean that a quick implementation took place; change often occurred at a very slow pace. The fixed characteristic largely dominated even into the 20th century and constituted a near monopoly of characteristics actually in use. Technology, economics and human inertia probably explain the slowness of change (see Putnam 1913, 1-53; EB 1911, 627-651; USCG Light Lists; IALA publications and other treatises on lighthouses and matters maritime).

Technology has had at least as much impact on marine markings message characteristics as that of colors and their meanings; the state of technological production has had bearing on expanding the range of marine messages. While much of the new technology existed before 1900, the mere existence of technology did not translate into rapid implementation. During this time technology was often in one of two states: a prototype state outside of the market, or within the market but not available on a mass-production basis. For example, optical apparatus for major lights was crafted on an individual basis during the 19th century. Fuel systems were perhaps less customized but neither were they mass produced. Frequently technological advances were available but at a slow pace which generated an expensive process. The economics of deep-water navigation supported major seacoast lights. But economics may have less adequately supported lighting apparatus for river and harbor systems. This resulted in simple and often primitive lighting existing in river and harbor channels while new technology, including more varied light phase characteristics, was found mostly at the major lights.

In the last decade of the 19th century various developments led to a diffusion of new technology: liquid-fuel and vaporized-fuel lamps, the introduction of electricity and acetylene fuels, and the adding of automated equipment and timers. Older forms of markings remained in place but they were to be altered in the new century (see Putnam 1913).

The resolution to a solutions of the railway problem colors and meanings began in 1899. (ARSPAPOS 1953, 74-75, 78; see also Killigrew 1949). A US academic, E.W. Scripture, noted that “signal colors could be determined by a careful study of the physical and colors conditions involved.”

(ARSPAPOS 1953, 75). This view attracted the interest of the Corning Glass Works which asked E.W. Scripture to set up a scientifically accurate and precise standard for the various signal colors. This work was understaken at Yale University by Professors Scripture and Churchill. The later joined Corning and established an optical laboratory.

In 1905 Churchill prepared an essay that proposed both general principles and specific methods for testing specifications for signal glass that would lead to standardization. He further noted that adequate glasses were actually available that would bring about a three-color signal system. These new standards included a red which eliminated any orange hue, a green with a slight bluish tint, and a yellow that would not be confused with green or red. Churchill's work also includes a lunar white, a blue and a purple all of a new formulation.

The Railway Signal Association (US) endorsed green for the proceed indication and yellow for caution in 1906. Individual railway standards fell away in the face of a general standard. In 1910 white was dropped for a clear signal, and the three-color system of red, green, and yellow was adopted. Color standards were also included for blue, purple, lunar white. Work continued for some years on the project though much of the work was completed in the pivotal year. (ARSPAPOS 1953, 74-75).

Aero aids to navigation began even in the earliest years of aviation. Lighted letters (using prismatic reflectors and filament lamps) were in use Germany in 1909 for airships (O'Dea 1958, 104-105). Parafin flares were in use in England before World War I; electric and parafin flares were employed by France during that conflict. Airport beacons, boundary and obstruction lights and wind indicators were in use in England shortly after World War I. (O'Dea 1958, 104-105).

Possibly the earliest traffic signal in the 20th century was one established in Paris in 1912 (Mueller 1970, 7-10 and following paragraph). It consisted of a kiosk topped by a revolving box painted red and white. Red indicated stop and white denoted go. That seems to reflect the older railway signal message pattern. The signal in question was ignored by Parisians and soon discarded. A semaphore traffic signal was installed in Detroit the following year with the new message pattern of green for go and red for stop. But a signal in Richmond, Virginia three years later reverted to red for stop and white for go message pattern. A non-semaphore traffic signal had been set up in San Francisco the previous year with red and green lamps. None of these early signals included a caution indication. The first signal with a caution indication may have been in Cleveland in 1914. The caution message in that signal consisted of a bell denoting impending light changes rather than a lighted message.

2 The Further Development of Messages, 1920-2000

For marine aids to navigation the changes of the late 19th century were continued in the new century. There was a notable degree of implementation of technological advances. Red and white continued to dominate marine color patterns. More extensive use of green did not take place until about 1925 for major lights. Green was undergoing employment for marking of bridges and for harbor lights in Europe (following a conference at St Petersburg in 1912) positioned red to port and green to starboard). Light phase characteristics did not undergo significant change (Bury 1978, 136; USLS 1918; Gibbs 1967, 99; Putnam 1913, 37, 39; Adamson 1953, 256; Conway 1915, 80; Weiss 1926, 35).

Technical changes underlying colors and meanings were more substantial. Electricity was introduced at the turn of the century and was well on to its way to becoming a major fuel by World War I though not yet a dominant one. Two types of acetylene gas appararatus were introduced in the first decade of the century. An improved oil fuel, incandescent oil vapor, was finding increased use. Electricifying of buoys began in 1917 and this greatly extended the system of lighted color messages. A major expansion of aids in the early 20th century brought lighted markings into less industrialized regions and more remote regions of industrial nations. (Weiss 1925, 35; Wesler 1966, 1024-25)

Experiments with different forms of light sources and expansion of light phase characteristics took place after this period. Nonetheless, much of the shape of modern marine aids to navigation was underway in the first quarter of the century.

Earlier editions have focussed on the role of D.L. Bruner in establishing a aero lighting code (see *Foundations* 2008, 90-91). While that is significant for early US aviation there is a need for a broader review of color messages. That review is based on work in Part J (*T-M Historical Survey* 2002). Boundary Lights were often white in the US of the 1920s while frequently red in other nations. There were seemingly other colors that found some usage: amber and international orange. Range Lights (within Boundary Lights) indicated approaches to runway. These were green in color. US boundary lights that supplemented obstruction lights were red. Obstruction lights were usually termed red though the alternate term of ruby was sometimes employed. Beacons were often white. The type of light varied from incandescent to acetylene, electric arc, and neon. European and Australians beacons were red neon.

By 1929 aero color messages had the following configurations: airport beacons exhibited a flashing combination of green and white (Black 1929, Appendix 9). Course lights, either red or yellow, accompanied the beacon messages. Yellow or white marked boundaries with green lights on superior approaches. Dangers were marked by red lights. This largely followed Bruner's work and has endured to a significant degree.

It was not until 1920 that a three-color traffic signal was developed. This signal, in Detroit, displayed red, green, and amber or yellow lamps. The caution message had the specific meaning of "clear the intersection." An unexplained delay occurred in adding a caution signal to the traffic signal despite the railway three-color system of the previous decade and despite the involvement of railway signal manufacturers in traffic signals. (Mueller 1970, 7-10).

The position of yellow to other colors in the signal housing varied. In some instances the yellow came after both the red and green; in other cases it overlapped with both. The familiar pattern of red/yellow/green was yet in the future.

The mid-1920s was a time of experimentation on several fronts. These experiments include work with purple and blue as possible signal colors. Other experiments worked on the design of graphics and signals, the standardization of signals, messages and colors, and the position of signal colors. But by 1925 much of the shape of modern traffic signals and messages was clearly present.

There have been major developments in many railway systems especially since World War II (ARSPAPOS 71, 76, 95-96). Older patterns of semaphore signals have been swept aside by color-light signals. Yet much of the railway signal colors and messages were established very early in the messages were established very early in the century and additional developments have been quite limited. There have been significant changes in the move from electro-mechanical to computerized systems but those changes did not greatly affect the basic level. Other changes occurred in lenses, color glass and fuels but none of these had significant impact on colors and messages. A new signal, the cab signal, created some change in message systems but only to a restricted degree. New patterns of signal configurations such as double yellows and flashing colors create changes in existing patterns yet they do not affect the basic system of colors and meanings. (ARSPAPO 1953, 44-46, 70-71, 76, 95-96).

Traffic control device colors are little changed from the 1920s. Though some colors have been added for signage including blue, green, brown, and orange. Arrow indications have been added to signals and a variety of symbols have been created for pedestrian signals. A type of signal has been created for pedestrian signals. A type of signal has been created that is “optically programmed” and which projects a color over a narrowly focusses area that cannot be seen unless the viewer is in direct line with it (this is reminiscent of marine lights (3M 1971, 2.3-2.5)*. While colors have remained the same for signals, they now employ larger lenses than older versions creating a larger visual image. (Mueller 1970, 13-16; cp the US MUTCD editions 1948, 1961, 1971, 1988, 2001). *The signal was produced by 3M from 1969-2007. McCain Traffic Solutions has produced a signal which is “almost an exact copy.” (Wikipedia 2013, 3M High Visibility Signals).

Green has become more common in marine aids to navigation, and a wider range of light phase charactersitics are also available. IALA-generated changes (1980) affected color usage and increased standardization for buoys and bea-cons. However, most of the colors and meaning were already in use even if in different configurations and arrangements. More recent additions to light phase characteristics include the composite group flashing, the Morse code and isophase forms. The occulting form formerly included two lights patterns especially in the US: those in which the period of light was greater than the period of darkness, and those in which periods of light and darkness were equal. Occulting now includes only those lights with characteristics with more light than dark; a new phase (which was added earlier in Europe than in the US), the isophase (or equal interval) includes only those characteristics displaying equal measures of light and dark.

Aero navigation aids, in contrast to other T-M systems, have undergone many basic alterations. Taxiway lighting, approach lighting, and high-intensity obstruction lighting are among the major areas of change. Aviation colors is a complex issue and a simple pattern of red=danger, yellow=caution, green=proceed has not always been employed. What can be termed the basic code is often altered by other configurations. This is the case with railway signals and marine aids. Road signals is virtually an anomaly with its simple essential code.

Many aeronautical navigation aid developments began in the 1940s and succeeding decades. US was active during this era and the new ICAO (began in a provisional stage in 1944) was also active. Other nations, NATO and manufacturers were engaged as well. The diversity of aids, colors, configurations of lights, design of light patterns and messages can not be examined briefly. The modal monographs and the historical survey can be consulted for more information. Ch 2B also reviews the use of colors. A key element in color is that of white which is important to many aviation systems. Red has a possibly confusing role: it can denote danger but it can be employed for approach lighting employing for approach lighting systems without denoting danger. Green denotes several messages but the basic meaning of proceed is limited. (See *Historical Survey* 2002).

ICAO has developed standards of significance for aviation; it also notes divergent practice in national systems as well. Key color usage aids includes aero beacons that displays white or white and green lights. Other systems may display variations though the basic meaning is in use. Boundary and Range Lights are of an older vintage but were listed by ICAO from the 1940s to the 1970s). The ICAO version included boundary lights with green lights and yellow lights for Range aids. US CAA ended boundary lights in the 1950s. (*Historical Survey* 2002, 93-94).

Taxiway lighting did not exist in early aviation because early airports were of a simple design and often floodlighted. Blue taxiway lights were introduced in about 1939 (Douglas 1977). The first standards for taxiway lights may have been that of the "Army-Navy-Civil Committee" (US) in about 1941. The IES *Lighting Handbook* for 1947 was the first "formal publication" dealing with taxiway lighting. The blue used for taxiway lighting is known as "signal blue," and unlike other colors there is only one blue in use. (Breckinridge 1967, 48; *US Standards* .... 1964, 26). The blue taxiway light is a fixed indication employing a clear/lamp with colored lens. (*Historical Survey* 2002, 93-94).

Taxiway lights were traditionally only blue in color. But more complex situations and the problem of a "sea of blue" (a large area of blue light) brought about changes. For a time ICAO employed blue for one side and yellow on the other. However, blue was to become the only color for edges. Green was used for centerlines; exit areas alternated green and yellow for taxiway. US FAA also employs two colors of blue and green. ICAO developed a variety of aids in the 1950s. These include threshold lights which employed green fixed lights. Edge lights displayed white joined with yellow at beginning of runways. Newer versions began with white followed by white and red and ending with red. (*Historical Survey* 2002, 93-94).

Additional aids in the 1950s included a variety of aids for visual approach slope indicators that could employ a variety of terms and versions. A key feature were messages that indicated when the aircraft was on correct descent path for the glide slope (or glidepath). An early version, VASI employed red for too low, white for too high, and red/white on path; PAPI also employed red and white as well but with a different configuration: Two white and two red indicators indicated on slope. A different system, PLASI, employed the rate of pulses to indicate correct slope. (*Historical Survey* 2002, 92-93).

Approach lighting also began in about 1939 (Breckinridge 1955, 15; CAA 1958, 44). Two colors were employed: white and red. A typical approach lighting system has three phases: white bi-directional lights, followed by white/red, and finally, red-only lights. This use of red is contrary to road and rail usage and is another example of the variant form of meanings that can be ascribed to red. Approach Lighting developments in the 1940s and 1950s became a very confused situation as various designs of systems and light apparatus were tried out. Different colors and multiple configurations were attempted. Despite complications there were two primary colors in use: red and white. White served as the primary color with red accompanying that color for specific levels of aviation. Strobe lights are added in many situations.

A second use of white is employed with sequenced lights (FAA 1981, 4; Breckinridge 1967, 44, 48). These lights were introduced in about 1950 at airports and often in conjunction with approach lighting at a later state. Such lights became omni-directional lights of a condenser-discharge or strobe nature. The color known as “aviation variable white” is within the variable source white category. This white is produced by the lamp unit itself rather than by colored lens over a clear lamp. Another form of strobe lighting is employed with a high-intensity obstruction lighting.

This survey has ranged over the greater part of this century and has touched on the several modes of transportation and the many forms of T-M. The focus of the survey has been on the colors and their meanings. It has been too brief to cover all points. Though it may offer an overall view of a diverse and complex topic.

Despite changes of many kinds the basic colors and the essential meanings of those colors (as well as variant meanings) remains largely unchanged. The nature of markings is generally conservative which means that colors, meanings and other message systems once established, even if in an arbitrary or accidental manner, often hold to that meaning. Changes in technology, design, and transportation may alter the pattern of messages, but more often than not, once a pattern is established it has a long life.

CHAPTER THREE

ELECTROMAGNETIC PROCESSES & ELECTRONIC T-M

3A Primer on Electromagnetic Processes

3A1 Electromagnetic Radiation & Waves

Electronic as well as Acoustical T-M forms were omitted in the first edition of *Foundations*; that first edition focusses overwhelmingly on visual forms. The 2nd edition rectified that omission. The acoustical coverage in that edition included an introductory statement for both T-M and acoustical science concerns. A similar coverage was added in the 4th edition for electronic forms.

The 19th and early 20th centuries lacked electronic T-M forms. During the past 75 or so years development of those forms have seen a rapid development. That development has eclipsed and even replaced both many visual and acoustical aids. This coverage, though brief, reviews underlying processes as well as providing a general introduction to electronic T-M forms.

Chapter 3A, the Primer, examines underlying electronic notions, 3A1, and the specifics of generation, propagation and reception of electromagnetic waves, 3A2. Chapter 3B reviews the various forms of electronic T-M forms in a tripartite arrangement: Multi-stations with single messages (3B1) and multiple messages (3B2); and single-stations with both single and multiple messages (3B3).

Source materials for this chapter are of a diverse character. Some sources are of a "how to" nature though not including actual navigation systems. Other materials are of a a handbook nature and are simultaneously practical and abstract in content. Yet other treatises focus on navigation with an emphasis on the propagation of waves as well as transmitting and receiving equipment. The discipline of physics takes up these matters in a more theoretical terms but has a lesser role in this study.

Electromagnetic radiation constitutes a transmission of energy. This energy is a result of charged particles that engage in a process of acceleration thereby becoming magnetic fields propagated in space and known as electromagnetic waves (Graham 1983, 60).

Electromagnetic waves include radio waves and light waves (sound waves are a different form of energy matter). They are "the mechanism by which electromagnetic energy (electromagnetic radiation) moves." (Wiki.answers 2013). They are made up of electric waves (or electric field) and magnetic waves (or magnetic fields. (Wiki.answers 2013). The elements are produced by a transmitter and broadcast through the atmosphere. Radio waves are one element of the electromagnetic radiation spectrum. These waves occupy about 40% of the lower end of the frequency spectrum; infrared, visible light waves and x-rays occupy other portions of the spectrum. The unit of measurement for the frequency is that of the Hertz unit (formerly termed cycle). A Hertz unit denotes signal frequency per second in cycles (e.g., a 10 khz frequency would be 10,000 cycles per second in alternating current). (Appleyard 1985, 1-2; Graham 1983, 60).

The radio wave spectrum includes frequencies from 10 kHz to 100 GHz. The spectrum can be expressed by frequency (cycles per second hertz units), wavelengths (distance in meter between high point of adjoining waves which are somewhat akin to water waves in appearance with crests and troughs), as well as in frequency bands (VLF, MF, etc). Electronic T-M forms employ some but not all of the frequencies. The following chart outlines frequency bands.

Hertz designations and relevant electronic markings:

Bands	Frequency	Examples
VLF	3-30 kHz	Omega 10.2-13.6
LF	30-300 kHz	Radio Bns 190-300
MF	300-3000 kHz	Radio Bns 300-535
HF	3-30 MHz	--
VHF	30-300 MHz	VOR 108-118
UHF	300-3000 MHz	DME 1025-1150
SHF	3-30 GHz	MLS 5
EHF	300-3000 GHZ (or 3 THz)	--

(Robinson 1985, Dodington 1982, Field 1985)
Legend: V=Very; L=Low; M=Medium; H=Hertz; U=Ultra; S=Super; E=Extremely; F=Frequency; kHz=kilohertz; MH= Megahertz; GHz=Gigahertz; THz=Terahertz

3A2 Electromagnetic Waves: Generation, Propagation, Reception

The radio portion of electronic communication is a means through which data is conveyed from one point to another without communication cables. The transmission of information signals is carried out by modulation (or alteration of the characteristics of a waveform) of a signal (often termed carrier) in a higher frequency. This modulated signal is translated into an electromagnetic wave that is propagated through the atmosphere to the receiving point where it is translated back into a modulated signal, amplified and "demodulated" into an audio and/or visual format that results in a meaningful message (Raffoul 1986, 1161; also Gibilisco 1985, 544).

The radio communication process follows a sequence: a) carrier modulation by the transmitter; b) translation of the modulated carrier by transmitting antenna; c) propagation of the electromagnetic wave; d) translation of the electromagnetic wave into a modulated sign by the "receiving antenna;" and e) "demodulation" or removal of the information from the signal by the receiver after amplification (Raffoul 1986, 1661).

Transmitters are often classified by the form of the modulation process. These include amplitude modulation (AM), frequency modulation (FM), phase modulation (PM), and single sideband (SBB). Choice of transmitter types is determined by application, frequency, and national and international regulations (Raffoul 1986, 1661, 1676; also Gibilisco 1985, 23-4, 391, 544, 653, 742).

Transmitters include a power supply, oscillator, and amplifiers. Oscillation refers to the current that oscillates (follows a pendulum pattern) and the oscillator creates and maintain a specific pattern. There are several forms including the crystal oscillator which provides a stable current through the process of injecting electricity into crystals (Gerrish

1989, 293, 296, 303).

Antennas can be classified in two ways: by frequency, and by radiation mode. The modes include elemental current, travelling wave, array, and apperture antennas. Radiation modes are determined first by wave length and then by frequency. The antenna has several parameters of which the the radiation pattern is the most important; it influences other characteristics of the antenna operation. The purpose of the antenna is to translate electrical energy into radiation energy (at the opposite end translation will be in the reverse order) (Raffoul 1986, 1668; see also Douglas-Young 1987, 19ff).

The reception aspect of the process includes a second antenna and a receiver. The receiver "demodulates" an incoming signal and thereby removes the data that has been transmitted. Incoming signals are often very low in volume and this requires an amplifier for the message to be usable. Receivers can be classified by modulation (as was the case with transmitting units) and also by equipment types. The most common form of receiver is known as a "superhyterodyne" receiver (Raffoul 1986, 1682).

Transmitters/antenna/a second antenna/receiver constitutes a technological configuration and process. At the core of that process is the propagation of radiated energy which contains a specific message. How the messages are worked out (Both in machines and in content) is considered in 3B while propagation is reviewed here.

How radio ways function from transmission to reception depends on wave frequency. A wave of a specific frequency propagates as does any other wave on the same frequency. Some sources speak of two forms of waves: sky-waves and groundwaves (Appleyard 1985, 3). The ground-waves can be further divided into direct and skywaves (Horn 1989, 462). All three forms are pertinent to this study whether or not waves are considered separately. Surface waves follow the shape of the earth. How far such a wave travels depends on frequency and the characteristics of the ground. Direct waves travel a "direct, line-of-sight path from the transmitting antenna to the receiving antenna." (Horn 1989, 462).

Skywaves may suggest that the wave ends up in space with little consequence. However, the ionosphere can cause such waves to refract -- depending on frequency -- and ultimately return to the surface and captured by appropriate receivers. The ionosphere is in several layers of which the D, E, and F layers have the most dense ionization. The layers are affected by various factors: whether it is a day or night, the season of the year, latitude, and sunspots. There is less ionization at night with the result that the D layer vanishes when there is no sun. The amount of wave refraction depends on ionization density and radio frequency. Lower frequencies result in higher refraction and at a given point the wave will be refracted from ionsphere to the surface of the earth. (Appleyard 1985, 4-5).

VLF and LF undergo propagation primarily through ground waves. These frequencies perform well over ocean water because sea water conducts well; many marine systems therefore utilize VLF and LF. MF uses ground and sky while HF generally employs skywaves. VLF and higher frequencies employ direct waves. (Douglas-Young 1987, 203-204).

3B Electronic T-M Forms: Signal Configurations & Receivers

3B1 Introduction

This material does not replicate the coverage of types of T-M and their messages (marine aids to navigation and aero navigation aids) though it may overlap with that coverage. The monographs on marine and aero aids focus on the marking and the message systems rather than a specific focus (e.g. electronics). This sub-chapter focusses on electronics including the receiver: what process is used to what process is used to convey the data and what is the receiver (initially a means of technology but ultimately the human user) seeing or hearing? The sub-chapter also includes the electronic dimension of other studies and expands that coverage. The expansion of GPS to include rail and road navigation -- as well as aero and marine forms -- has a larger presence here than in older editions of this study.

There are a variety of classification schema (whole or partial) for electronic navigation systems. For example, Maloney refers to Hyperbolic/Rho-Theta/Rho-Rho forms (Maloney 1985, 443-444); Raffoul includes a radial and hyperbolic bifurcation (Raffoul 1986, 1936). Dodington offers a schema of Rho-Rho, Rho- Theta, and Theta-Theta (Dodington 1982, 25-80). Rho-Rho refers to distance measuring, Rho-Theta to distance and bearing measurement, and

Theta-Theta to bearing measurement.

Electronic T-M forms can be placed in one of four categories:

a) Multi-station at multiple locations with single message (MSMLSM). (3B2)
b) Multi-station at one location with multiple messages (MSOLMM). (3B3)
c) Single-station with single message (SSSM). (3B4)
d) Single-station with multiple message (SSMM). (3B4)

3B2 Electronic Signal Configurations & Receivers: Multi-Station at Multiple Locations with Single Message

The term “Hyperbolic” is interchangeable with that of the classification category of this study. This is the largest segment of electronic T-M forms and encompasses systems dating back to World War II as well as more contemporary satellite systems. It is also the largest segment of this study though GPS has attained greater significance as a safety aid. The word hyperbolic comes from the geometric term “hyperbola” and refers to the form of curved line represented by that term (Maloney 1985, 442). The electronic markings of this form create hyperbolic lines in a pattern that results in lines of position indicating location of the ship or plane employing the system. It may prove to be more workable to describe the operations of various hyperbolic devices rather than hyperbolic processes with references to individual systems. Vignetttes of system backgrounds provide understanding on the workings of individual markings.

Hyperbolic aids can take many forms. And many of these systems are obsolete or employed only to a limited degree. They include Decca which includes a variety of related systems. The overarching term of Loran encompasses a series of systems ranging from A to E. Omega represented an advanced system that is somewhat at variance with the basic hyperbolic aids. Consol and Toran are included though of a different approach to navigation.

Decca is a hyperbolic system with marine and aero applications. It is a system that employs continuous wave transmissions and phase comparison measurements. Each unit has a master station and two or three slave stations. It transmits on frequencies between 70 and 130 kHz. There is a fixed ratio between the frequencies of the several stations of 5, 6, 7, 8, and 10. The stations broadcast a continuous wave (cw) signal at different frequencies but interlocked through frequencies which follow a fixed ratio to one another. The signals are not modulated. Decca is a coastal aid that has a nominal range of 240 nmi (444 km). It is a privately-owned and seemingly the only major radio-navigation system in that category. Other Decca systems include Delrac, Dectra, Hi-Fix, Lambda. (T-M Database: Marine 2007, 292-294; Maloney 1985, 462; *International Marine Aids to Navigation*, 2010, 189).

The Decca system requires special receivers that are at variance with both standard radio receivers and hyperbolic receivers. Nonetheless, it is an easy system to apply. The slave stations are named after primary colors and the phase meters of the receiver are color-coded to match the slave stations. The receiving unit is in effect four receivers in one. The unit modulates the four frequencies resulting in a single shared frequency. This creates a phase compatibility allowing determination of the location of the vessel. The comparison of incoming transmissions is that of phases rather than time; that was a feature of the now-closed Omega system as well. (Maloney 1985, 462; *International Marine Aids to Navigation*, 2010, 189).

Loran designates a group of Radio Position Fixing Systems. The development of earlier forms took place during World War II. The forms include Loran A through E. Alternate and earlier names included HF Loran, LF Loran and SS Loran. Related and antecedent aids included Cyclan, Cytac, GEE and Hyperbol. Principles of operation include radio signals in pulse form, emissions by two or more transmitters, and shipboard equipment that measures signal arrival differences which leads to LOPs. (T-M Database: Marine 2007, 296).

Loran-A is a hyperbolic MF device with pulse envelope matching of transmitted signals. Both ground and sky waves are employed. Loran-A was formerly known as Standard Loran. It is largely obsolescent though some usage was continued by Chinese and Japanese fisherfolk into the 1990s. (T-M Database: Marine 2007, 296).

The receiver for Loran-A is somewhat similar to standard receivers though modified for Loran receptions. The receivers transfers data to a mechanism somewhat like a digital clock. Two such readings supply the data needed for establishing location. One line-of-position (LOP) is established by comparison of time differences from the master and one slave nation. A second reading is gained by utilizing the master and another slave station, or by the same stations for double transmissions. Maximum range was 800 nmi. (Part A 2008, 105).

Loran-B is a non-current form using LF transmissions. It is possibly related to World War II LF Loran. It employs the same frequency as Loran-A but it is more accurate since it utilizes both envelope matching and cycle matching within the envelope. (T-M Database: Marine 2007, 296). Loran-B was superior to Loran-A to some degree. However, a third form, Loran-C replicated that higher quality. ((Part A 2008, 105).

Loran-C is an LF hyperbolic device with multiphase transmissions containing eight pulses per transmission (and a ninth for station identification). Phase coding is a feature of transmissions; pulse and pulse groups change according to a sequential pattern. Time difference measurement of signal arrivals lead to a LOP and two LOPS create a navigation fix. Loran-C stations consist of a master station and two to four slave stations. It has long base lines and long distance capabilities. It is obsolescent at best. (T-M Database: Marine 2007, 297).

Loran-C has a master and two or three slave stations. It operates on 90-110 kHz frequency. It transmits eight-pulses per transmission; Loran-A had one pulse. LF achieves transmission syncronization thereby expanding coverage but with the same amount of radiated power. It has a range of 1500 nmi (Maloney 1985, 462; also Cutler 1986, 1942). Loran-C matches cycles within pulses rather than the envelopes of pulses as was the practice in Loran-A (Maloney 1985, 462, Cutler 1986, Markus 1978, 371).

Reception and measurement require at least two stations and may utilize three or four. Receivers may be modified Loran-A models or they may be computerized systems that are fully automatic. Measurement employs two methods: time measurement of the difference in the arrival of signals, and time measurement of the carrier frequency. (Part A 2008, 105).

Loran-D is a portable form of Loran-C which found employment in military operations. Loran-E is a non-current MF/HF system employing skyway synchronization or matching or both. This system was developed in the late period of World War II but no frequency allocation was available for it. It appears to be identical to SS Loran. (T-M Database: Marine 2007, 297).

Omega was a truly global system during its years of oper-ation. It operated on a VLF frequency spectrum of 10.2 to 13.6 kHz. Omega consisted of just eight stations worldwide. The stations transmitted time pulses at four frequencies of 10.2, 11.3, 13.6, and 110.05 kHz. The eight stations did not require a master-slave pattern. Range was virtually without limits (Robinson 1985, 37-3; Maloney 1985, 468). Receivers measured differences in phases rather than in time in contrast to Loran-A. Since there is no master-slave pattern any two stations could be used to gain the necessary data. The system did constitute a hyperbolic-based positioning navigation. Omega was closed down in 1997. (FRP 1-11, FRP 1999, 1-10). The development of GPS is the most important reason for that system to gradually shut down.

Consol is an anomaly not only for hyperbolic systems but for all electronic systems since it occupies divergent and seemingly contradictory places in various classifications. Consol (the UK term) began as the German "Sonne" system in World War II. It is hyperbolic because it employs multiple stations yet it can better be described as a radial system. Radial systems are so termed because a single transmitter radiates a 360 degree signal which forms "a straight-line bearing from a single object." In a radial system, because the baselines are very close together (and unless a ship is near the station), the lines are radial or straightline not hyperbolic. It has been employed by both aero and marine navigators. (Cutler 1986, 1937, 1946-46; also Consolan, BP-5).

A US version, termed Consolan, is restricted in coverage. A Russian (Soviet) form under the acronym BPM-5 is somewhat broader in coverage. The US form is based on a two-station form while the former USSR type has a five-station configuration with dot and dash characteristics of a narrower design. (Part A 2008, 104).

Toran is regarded by some navigation sources as a hydrographc aid and by other sources as an aid to navigat-ion. It is a phase difference comparison system. Signals are HF and are transmitted by two confocal transmitters and one reference transmitter. Range is 300 miles on a frequency of 2 MHz (IALA 1970, 4-4-340).

Satellite navigation systems are newer than most other radio aids yet they have quickly reached a near dominant state among radio aids, and, for that matter, many visual and audio aids. For several decades Transit served many global navigation needs. It consisted of at least four satellites which broadcast on continuous frequencies of 150 MHz and 400 MHz. Receivers determined location from position data of the satellite and by Doppler shift measurements. During the last decade of the 20th century Transit was phased out. Other limited use satellites systems included Lorsat and Starfix. A Soviet system, Cicada, was similar in operation to Transit. (Robinson 1985, 37-6; see also *Federal Radionavigation Plan* editions).

Increasingly Global Positioning System (GPS) and a system for supplying corrections for precise navigation (DGPS) have become of critical significance for navigation. GPS can be regarded as a multiple station system with a single message. It is therefore not hyperbolic but instead employs a pseudo-range and time measurement system. With some two dozen satellite systems in place it supplies global needs. The signals use frequencies of 1575.42 and of 1227.6 MHz. Receivers pick up signals from four of the satellites and quickly determine position (latitude and longitude) and also altitude and velocity. (Hobbs 1990, 584-5). Differential GPS (DGPS) provides corrections through various narrow parameters. GPS and DGPS already offer easily read information for pedestrians, hikers as well as a greater range of data for all transportation modes. (FRP 1999, 1-9; National Civilian 2000, Modern Magellan 1998, 63).

3B3 Electronic Signal Configuration & Receivers: Multi-Stations at one Location with Multiple-Messages

This category refers to separate transmitters that are in close proximity to one another and which operate as an integrated system. Examples of this form include two aero systems: Instrument Landing Systems (ILS) and Microwave Landing Systems (MLS).

Instrument Landing Systems (ILS) is a long-established system that was intended to be replaced by the Microwave Landing System. However, MLS developed more slowly than anticipated and the development of GPS and DGPS has superseded completion and future use of MLS. ILS has three components: Localizer, Glide Slope, and Marker Beacons. (Part B, 1992; Field 1985, 30-31; Robinson 1985, 37-4; Douglas-Young 1987, 447-449). These are the sources for the remainder of the sub-section as well.

The Localizer, positioned 1000 feet past the runway stop end, has two antennas (or a single antenna with two patterns) provided azimuth guidance. The antennas have a 90 Hz left-hand pattern that is also modulated. The receiver contains a “course deviation indicator” (cdi) with two needles which indicates the correct course for an aircraft including course correction data. The localizer broadcasts on 109-112 MHz frequency pattern.

The Glide Slope, located 1000 feet past the approach end of the runway and off to one side of the runway, broadcasts on a frequency between 328.6 and 335.4 MHz. This unit provides altitude information including indications if the plane is above or below the correct course.

The final component of ILS are the Marker Beacons. There are two to four units and they mark “decision height points.” They transmit on a frequency of 75 MHz. They may broadcast a continuous wave signal or a coded signal of dots and dashes. The receiver contain indicators that are both audio and visual. In the US form the first beacon marks the point where the glide slope signal is encountered; the second marks the decision height at lower category airports; the third denotes decision height at lower category airports. A fourth beacon may be in operation at non-precision airports. The incoming signals are combinations of dots and/or dashes that differentiate between the beacons.

The Microwave Landing Systems broadcasts on 5 GHz frequency which is SHF in contrast to the VHF of ILS. At that frequency, and with its narrow beam, MLS is less affected by irregular terrain and weather situations than ILS. The localizer and glide slope together create one approach path which is at a fixed angle of descent. The MLS azimuth aspect consists of a microwave beam that examines a broad area either side of the centerline, and the elevation aspects reviews a large area of elevations. The receiver unit in the aircraft, by measuring the time of the incoming pulses, can determine the exact of the aircraft. A third aspect of the MLS, the Precision Distance Measuring Equipment (P-DME), provides on-going distance data in contrast to the beacons of ILS which gives location indications at stated points. (Field 1985, 31-33).

3B4 Electronic Signal Configurations & Receivers: Single Station - Single & Multiple Messages

Single stations include two forms: single messages, and multiple messages. Single stations, of both forms are fewer in number and in scope than multiple station units. Both are discussed in this segment. It can be noted that some single units may at times work in tandem. Many of these systems are radio beacons and related devices; some radar assemblies are also included.

Radar is a vital element in navigation that is often employed for ship- and plane-based uses. Written sources on radio navigation often do not include ground-based radar systems. These systems may exist though of more limited scope. Devices known as radar reflectors are commonplace in marine navigaton. They are passive rather than active devices. Radar reflectors are objects so shaped that shipboard radar can more easily spot and identity an aid to navigation so equipped. "True" (active) radar aids include Racons and Ramarks. The racon, a secondary form of radar also known as a transponder beacon, needs to be triggered (interrogated) before operating; the trigger is a shipboard radar system. Racons can transmit either code or continuous signals. The receiver by actualizing the racon receives bearing and distance information. If coded the radar unit can determine the location of the beacon as well as its own location. (Maloney 1985, 48, 226, 223-234; also Kennedy 1985, 609; IALA, USCG LL, Parts C & D 1988, 2nd ed; also for following paragraphs).

Ramarks are a primary form of radar since they do not require a receiver to "ignite" their transmissions. Ramarks broadcasts an omnidirection signal of a continuous nature. They provide bearings for a ship though not distance or range information. The receiving screen will illuminate a "radial line at the bearing of the beacon." (USCG LL Pacific 1979). The frequency of the beacon is either the spectrum of marine radar frequencies (3 GHz or 10 Hz), or of the "beacon band" which is slightly less than GHz.

Radiobeacons (termed Non-directional Beacons, NDB for aero usage) are a LF and MF electronic device. Transmission for marine purposes are on frequencies between 207 and 385 kHz. While aero forms are on frequencies of 190 to 425 kHz and 510- 535 kHz. Aero forms can have a coded (dots and dashes) patterns or a continuous wave that has been modulated. Marine forms transmit dots and dashes in pattern similar to light characteristics though in a different energy form. Receivers are radio direction finders which constitute a special form of radio receiver accompanied by a directional antenna.

The remaining units can create some measure of confusion: VOR, DME, Tacan, Vortac. The first two are separate units that arre often collated; Tacan is a primarily military system that includes VOR and DME functions and VOR brings together together both civil and military electronic systems (see Part B, 2nd ed).

VOR (VHF Omnidirectional Range) is an aero system. It transmits on 108-118 MHz frequency spectrum. It contains two signals: a reference signal that is non-directional and one that is omnidirectional. The receivers determines bearing by measuring the phase differences between the two signals. The range is 100-200 nautical miles (Robinson 1985, 37-4). A second form of VOR known as Doppler VOR utilizes a large antenna arrray with the transmitter (Dodington 1982, 25-82).

DME (Distance Measuring Equipment) consists of a ground-based transponder and the aircraft equipment (termed an interrogator) which is both a transmitter and a receiver. The airborne unit transmits a signal that can be identified by the interrogator. By measurement of the time that is consumed in the double transmissions-receiving process the distance can be determined. Frequency band for the interrogator is 1025-1150 MHz and for the transponder, 962-1024 MHz. (Robinson 1985, 37-5).

TACAN attaches a bearing measurement function to DME. In some nations a system known as VORTAC includes Tacan in place of DME (Dodington 1982, 25-87).

CHAPTER FOUR

ACOUSTICAL PROCESSES & ACOUSTICAL SAFETY AIDS

4A Primer on Acoustical Processes

4A1 Introduction & Terminology

Acoustical processes and the resulting T-M forms requires a review in this study even though it is not a large topic. Acoustical processes begins with a primer analogous to those for light, electronics and design (4A). It is divided into an introduction with definitions, and an explanation of acoustical processes. Chapter 4B examines the type of sound signals, messages, and impediments to reception of messages.

Marine aids to navigation have historically employed the most prominent part of acoustical signals that included diaphones, bells, gongs, whistles among other forms. But sound signals were only a small part even of marine aids. Some bells are included with rail and road signals. Other signals included explosive aids for railways and audible pedestrian signals for road intersections. A more peripheral signal is that of electronic mechanisms which translate electromagnetic energy into audio signals at the receiving point. This aid is treated in Chapter 3.

Acoustics is the science of sound. Sound is mechanical energy that radiates through a medium (e.g., water, air) and created by a vibrating object (Albers 1965, 1-2). Pohlmann describes sound “as a wave motion in air or other elastic media.” It “can also be viewed as an excitation of the hearing mechanism that results in the perception of sound.” The former is a stimulus and the later as sensation. (Pohlmann 2009, 1). The mechanical radiation of sound waves is an energy form distinct from the electromagnetic radition of light and radio waves. Acoustics, in the view of Everest (1987, 7), has two natures or phases: the physical and the psycho-physical. The two phases are intertwined to a considerable extent. However, Lindsay sees the physical as fundamental and psychoacoustics as a branch field. Psychoacoustics includes the reception of sound energy or the hearing aspect of the process. (Lindsay 1966, 2).

Giancoli (1988, 382) notes that sound follows a three-part process: a vibrating object, sound waves, and the detector whether ear or instrument. Explanations of how the process functions can take various approaches including descriptions of wave lines purporting to represent a transmission of sound, or mathematical formulae, or railway box cars crashing into one another, or dust in tubes, or cork discs floating in mid-air. A more comprehensive approach is that of the energy transfer model. Truax notes that this model is the basis of most treatments of sound (Truax 2001, 3-4).

Truax’s major focus, a communication approach that centers on the movement of information rather than on energy, has had less significance for past editions of this study than his prefactory remarks on energy transfer. However, the communication approach is vital to T-M and increasingly so. Acoustic aids are integral to communication studies and an understanding of semiotic processes.

Nonetheless, the concern with energy transfers is pursued here. The inner workings of acoustic devices requires coverage. The following segment provides a brief exposition of more technical forms. The concern about communication is taken up more adequately in the first chapter. Part K, *T-M: An Integrative Systems Perspective: Communication, Information, Semiotics* (2011) can also be considered. See "Acoustic Indicators" (63-65). Everest deals with a technical approach though he also notes that his work "concentrates on sound as a medium of communication." (Everest 1981, 8).

4A2 Acoustical Processes

The energy transfer model perceives acoustical behavior as a grouping of energy transfers between an originating point and a receiving point. It studies the process of occurrence, the degree of efficiency, and factors that can alter the process. The energy begins with an object that vibrates and thereby radiates the created energy to a medium (air, water, a solid object, etc). The radiated energy is propagated through that medium thereby displaying various char- acteristics including velocity and frequency (Truax 2001, 4-5).

The process in more complex terms includes several dimensions. The first aspect consists of a struck object that moves, or more correctly, oscillates if only slightly. The object moves from **o** point to a maximum outward then returns to the **o** point, then to a maximum point in the opposite direction, then back to the original point (approximating like a clock pendulum though the motion of a tuning fork would be closer to the process) (Chedd 1970, 11-12). This acoustic motion is termed a "simple harmonic motion." It is often visualized with wavy lines (somewhat akin to oceanic waves). The greatest distance of movement constitutes the amplitude of the oscillation. If the movement is plotted as a curve the crest of the wave is the amplitude since it is farthest from the original position. The curve is technically known as a sine curve though the waves are more correctly termed longitudinal waves (Chedd 1970, 10-12; Giancoli 1988, 382).

The distance between the crests, or peaks, of the waves is termed the wavelength of the energy transfer or motion (Chedd 1970, 12, 15-16; also Giancoli 1988, 359). The velocity of the movement is another element in the process. The velocity is determined by the density (how close the molecules are to one another) and elasticity (the degree that a substance can "bounce" back to its original shape). The more the elasticity and the less the density the greater the velocity. It may be thought that sound would travel faster in gases than in solids and liquids because of the low density. However, the much higher elasticity of solids and liquids results in higher velocity in solids and liquids. For example, sound travels at the rate of 5050 meters per second in water but only 340 meters per second in air. Frequency is measured in Hertz units: how many wavelengths in one second. Fre--quency then is indicated by wavelength and velocity (Chedd 1970, 12, 15-16; also Giancoli 1988, 358-359).

The functioning of mediums is not simply a result of what substance they are composed of. The temperature of a substance affects the velocity of the sound waves, and temperature variations within a medium further affect the process. The several dimensions of the process present an interrelated front: propagation of velocity is a component of the medium, frequency is a component of the medium, frequency is a component of the vibrating object, and the wavelength within a medium is a result of the frequency and of the velocty propagation (Albers 1970, 28).

One topic in acoustics that impinges directly and immediately on both physical acoustics and psychoacoustics is the attentuation, or impediments, to propagation of radiated energy. This impediment results in the reduction of sound energy to the human ear Albers notes that when particles are put in motion there is resistance to that process in the form of friction that takes the form of heat (Albers 1970, 29). This means that attentuation occuring during the process of propagation causes the waves to lose intensity. This attentuation is a component of the medium and what takes place in medium. And what takes place in one medium can be at variance with another medium. Even within a medium differences can occur because of the frequency of the wave. Other impediments that can affect wave performance are discussed in 4B as they are often part of marine fog signal performance. (Albers 1970, 29).

Further topics relating to sound include the pitch, the intensity of sound (loudness), quality of sound, and spectrum. The first two factors refer to a "sensation in the consciousness of the listener" though they can also be measured. These elements refer to as well to generation and propagation of sound waves. Pitch refers to whether a sound is high, low, etc. Pitch is determined by frequency but in inverse proportions so high frequency brings about a low pitch and a low frequency creates high pitch (Giancoli 1988, 383).

Loudness relates not only to human hearing reception but also to intensity of sound waves; however, the relation is not one of direct proportions. For example, a sound wave that is twice as loud as another is ten times greater in intensity. Intensity is measured by decibels (the scale of measurement is a 'bel' [after A.G. Bell] and a decibel is 1/10 of a bel) (Giancoli 1988, 385). A third element is that of quality (without the connotation of inferiority or poorness). Quality can be referred to as timbre or tone color especially in music. The term tone is sometimes used in reference to fog signals (for example, the tone from a gong is distinctly different from a sea-activated whistle). (Giancoli 1988, 392).

The spectrum of light (within the electromagnetic spectrum) is matched in the acoustical spectrum by a range of sounds audible to the human ear. In the electromagnetic spectrum ultraviolet and infrared frequencies can not be seen by the unaided eye, and in the acoustical spectrum ultrasonic and infrasonic sounds can not be heard by the unaided ear (Everest 1981, 18). Humans can hear frequencies of the sound spectrum from 20Hz to 20,000 Hz. The ultrasonic frequenies are above 20,000 Hz, and infrasonic are below 20 Hz. Ultrasonic and infrasonic frequencies can affect humans even though not audible. (Giancoli 1988, 383).

4B Acoustical Signals Processes & Messages

4B1 Types of Vibrating Instruments, Generating Sources, Messages & Impediments: Marine

Earlier editions divided these segments into types, and messages and impediments. The modes were included in each of the segments. This edition includes both segments together yet divided between the two sets of modes: marine, and road, rail and aero. Marine constitutes a unit since it represents many acoustic devices even if many forms are obsolete.

The vibrating process and the resulting sound (tone, loud ness, pitch) can be created through a variety of means. The means, and technological configuration may not appear to be vital in this treatise since the primary concerns are the generation, propagation and reception of sound. Yet historically the details of the process have been a primary element. Early in the 20th century (the following examples are drawn from the US Pacific Coast; though examples from other realms are available) a whistle fog signal entry (fixed location), for example, in a Light List not only listed the energy form (often steam), but the length of the trumpet as well. The units were often 12” in length though some 10” length were employed. (US Lighthouse Service, *Light List*, 1918). Modern T-M forms may omit mention of the means and mechanism.

Sirens (air powered) were listed by class (which were often first class) models. Reed horns (energy sources are often unstated) were listed by classes as well (very often 3rd class). Fixed lights were also divided into classes known as orders. This practice had practical value since, for example, a first-order lens (920mm/36” in diameter) was very different in visual effect from a sixth-order lens (150 mm/just under 6”). However, it seems debatable whether even a seasoned mariner could tell the difference between a 10-inch steam whistle and a 12-inch steam whistle. Perhaps the extra two inches of trumpet altered the pitch to a discernible degree. (USLH *Light List*, 1918).

But contemporary practice has devolved to a point where fixed fog signals are dominated by diaphragms forms. The last-named form so dominates the field that fog signals are frequently termed horns without designation of the form of vibration, energy source, dimensions of the trumpet or other features. The 1990 USCG A/N Manual speaks of sound signals without reference to the form of vibration. Automatic Power (merged with Pharos Marine) lists the form of vibrations (USCG 1990, 7-1 ff; Pharos Marine ca. 1989). IHB 2004 includes a broad swath of fog signal devices yet the actual employment of those signals is limited; perhaps miniscule. (IHB 2004, A-5, A-6).

Marine explosive fog signals were passed over in previous editions. However, *Historical Survey* provides coverage of explosive forms. Explosive signals in the form of cannon were already a well-established fog signal forms. Even in the later 19th century experiments leading to new forms of explosive signals were developed in an effort to find the most effective cannon for fog signals. There were also experiments with gas guns and rockets. (HS 2002, 169-187; Renton 2001).

The most successive, and long-enduring, explosive signal was a tonite charge with detonator. This aid proved to be workable at off-shore light stations since machinery was not needed. The device was attached to the gallery of the lighthouse and then periodically detonated. This has been referred as a rocket or sound-rocket. From a vantage point of sophisticated aids it may seem a primitive aid yet it was effective in an earlier era. Acetylene gas guns may have been employed in the US in the early 20th century though they may have had a short lifespan and only of limited usage.

(*Historical Survey* 2002, 174).

A major motivating power for maritime sound signals is that of the sea. Many buoy-based signals continue to depend on the action of the waves. This is an uncertain energy source since waves are more common with stormy conditions when visibility is more satisfactory. Waves are less prominent in more calm seas which are more likely to be accompanied by fog. A sea-activated gong, whistle, or bell buoy may create a clangorous situation when least needed.

Bells and gongs are activated by tappers rather than by clappers (a point that might generate a semantic controversy) since the bell or gong is struck not by a single clapper within the bell but by several tappers outside of the bell or gong. The tappers are installed on the buoy framework so that they swing freely even with slight movement of the buoy thereby hitting the bell with more force than a single, internal clapper. The process for the gong is somewhat different in that one tapper strikes one gong. Gongs are flat-bottomed, and nearly dish-shapped containers that are grouped together. That may suggest the oriental gongs for British buoys at an early date were imported from China (Douglas and Gedye EB 1911, Vol. 16, L-Lord Advocate, 647).

Whistle buoys have a more complex system than percussion forms. Wave action causes air to move up and down the counter- weight tube (located below the float component of the buoy). The downward wave action pushes air through the whistle valve mechanism thereby creating the whistling sound. “Natural-powered” fog signals can also include bells rung by human motive power though that is mostly in the past (USCG 1990, Ch. 2).

Bells can emit a regular sound indication through the use of a bell striker (IDAMN 1970, 3-2-290). This machine periodically strikes the bell with a piston which emerges from the striker. An older system required hand-wound weights that activated a hammer striking a bell at regular intervals (IALA 1970, 3-2-245). An electronic process is capable of simulating the sounds of gongs or bells (Pharos Marine). PM speaks of “an audible output which closely approximates the sound of a bell or a gong” for that process while USCG refers to a “bell-tone conversion assembly” that includes one or more strikers. (Pharos Marine, 97; USCG 1979, 7-28; Wheeler 1990, 14). It is debatable to what degree simulated sound is similar to the traditional older forms.

Other forms of fog signals require either the passage of air or stream or an electro-magnetic process to create sound patterns. The sound for sirens is created by activating a disk or rotor with compressed air or with electricity. A variant form consists of a rotary shutter through which compressed air is passed. The siren is now less often employed and then mostly at bridges. The siren is similar to a fire siren though the messages patterns are different. (IALA 1970, Ch. 3; see also DMA N.O. #114, 1983; USCG Manual 1953, Light Lists [excerpts for Pacific Coast, 1957-2005; additional editions for other regions]).

Diaphones, now rarely used, consist of a slotted piston driven by compressed air. A second version of the diaphone creates two tones with one operating at a high pitch and the other at a lower pitch. The reed horn, now probably extinct, consisted of a reed across which air was passed. This may have been a short range signal since it was usually located in harbors rather than at coastal locations. Another probably obsolete signals, the nautophone, created a sound similar to the reed but through a diaphragm process. It can be noted that IHB 2004 includes a listing and description of a very broad range of signals. Many or most are seemingly obsolete though listed and possibly in use only to a slight degree. (IHB 2004, M-12).

So far, all of these signals, sea-activated and otherwise, propagated sound through the medium of air. One other process, probably now out of use, employed water as a medium. Water has proven to be a more consistent and reliable medium for sound. This form included the submarine bell and the variant form of the submarine oscillator. This signal rested on the sea bottom and was attached to a lightship or was suspended below a buoy. A shipboard receiver was required to clearly hear the signal though the sound was capable of being heard even without that aid (Putnam 1913, 51-52; see also Fay 1963).

Messages for acoustical signals can be divided into categories of regular and random charactistics for marine markings. A bell buoy would be random while a fixed signal would have had a set characteristic. Presumably FA 262 signals (which is perhaps the only short-range signal in use) have a steady message but without variation. In the past the US Coast Guard had nine possible fog characteristics which indicates -- as is the case with other marine aids to navigation -- an increase of standardization. The characteristics, though limited in scope, provide different message formulations for several horns in a given area. Fog signals have been less varied in both types and sizes of vibrating instruments while distinguishing characteristics are increasingly important. Fog signals, though in reduced numbers, continued to carry out a mission of providing a loud and raucous sound for mariners though of recent times that mission is ever more reduced. (USCG Light Lists PCPI 1962 contained that information and messages but within a few years most of it had been dropped; USCG Manuals [several editions], LNMs 2007 [regional edition, Seattle, multiple issues]).

Impediments in fog signal operational distance has been a long-enduring issue with marine signals. This is not an issue in road, rail and aero forms for short range and ultra-short-range operations. A range of feet or inches eliminates the problem of impediments for reception of such signals. However, marine signals are comparatively long-distance signals and impediments can be a problem. The older and now obsolete submarine bell was a more consistent and reliable signal than that of air. Water is more dense than gases but it is also more elastic than air thereby allowing for great velocity and a more consistent, reliable medium. But other factors doomed the submarine bell. Ships needed sensors attached sound signals but did not require shipboard technology. The bell could be heard by the unaided ear though less adequately (Putnam 1913, 51-52).

Air signals travel more efficiently through cool air masses than through warm air masses. Frequently a fog signal can encounter air currents of mixed temperatures with the result that a signal travelling through a current of cool (and doing so reliably) encounters warm air that throws off the direction of the signal. For example, a navigator in a direct line with a fog signal may gain the impression that the signal is actually off to his/her right because of the deflection. Signal performance can be affected by other variables as well. The distance that a signal can be heard may vary so that the range of the signal also varies greatly from one occasion to another. A signal with two tones can be so affected by the atmosphere that one tone can not even be heard. Even limited altitude can affect performance: a signal heard from a ship's mast may not be heard on deck (USCG Light Lists). Atmosphere over water is a fertile field for variations which leads to diversity in sound quality. Fog signals were viewed as vital though marked by limitations. They function as warning devices not directional devices. (USCG Light Lists [see previous comment on page 138]; *International Marine Aids to Navigation 2*010, 210).

4B2 Types of Vibrating Instruments, Generating Sources, Messages & Impediments: Road, Rail and Aero

Coverage of various forms of devices have increaed in the 2008 edition and more so in this edition. Audible pedestrian signals are increasing in usage and thereby become a more vital sound device than in older editions. Coverage of railway explosive signals was limited in previous editions but increased here; cab signals have been included in this edition. A solitary aero fog signal is added to this study.

Sound signals for railway take several forms including railway fog signals or detonators, cab signals, fuzees and occasion-ally sound signals attached to trackside signals.

Railway fog signals have been in use more than 150 years; they are also known as track detonators or simply detonators; “Bangers” was a colloquial term. An early version consisted of a small, flat tin with lead “ears” and contained gunpowder and matches. Seemingly it has changed little since its invention. Messages have taken several forms. UK and Germany employ a single detonator indicating stop. Two detonators indicated stop in South Africa but then proceed with caution if line was clear; three called for a full stop until approval to proceed was given. In the US one explosion indicated stop and two denoted caution. A report of the International Union of Railways (1964) indicated that most rail systems employed the device. (*Historical Survey* 2002. 181-182).

Other railway sound signals include the fuzee which seemingly was the equivalent of the flare. It was a form of chemical fire that could be thrown off the train or inserted in the ground. (HS 2002, 182-183). A signal known as the fog gong (UK) was attached to a lighted wayside signal. It sounded off in foggy conditions preventing a train crew from running past a signal at danger. (HS 2002, 184).

Cab signals incorporated sound devices as well as displaying visual signals within the train. Signals indicated a variety of messages including a signal at danger that was passed, and when clear. Speed reductions and other restrictive message could activate signals. The sound forms included bells, whistles and klaxons. (HS 2002, 183). Some aeronautical electronic aids are translated not only into visual images but sound messages as well. *Historical Survey* 2002 includes more extensive coverage. (HS 2002, 183).

Road and rail T-M bells (those found at railway crossings) can be regarded as either a road or rail signal or both; both transportation forms included the topic. Bells of whatever form provide an insistent and staccatto sound that emits more than a 100 strokes per minute and some forms sound off more than 200 times per minute (WBAS 1983)

Bells employed in rail and road service are much smaller and of less power than their marine counterparts since they are short-range signals. The bells are electro-mechanical, or electronic (the latter also has a mechanical dimension; see following Note). A weighted spring strikes the gong (this may create another semantic issue: the object struck in a “bell” apparatus, and thereby vibrates, is a gong). This gong approximates the shape of a sea-going buoy gong (though much smaller) though in this later case the gong is part of what is termed a bell rather than a signal in its own right. The electro-mechanical form contains a weighted spring while in the electronic form (which contains a mechanical dimension) a programmed plunger hits the gong (Westinghouse Brake & Signal, Australia, 1983 Catalogue). Bells and gongs are employed in some nations in Europe. Gong can be an aid in itself as well as a partial component of a device termed a bell. (*Historical Survey* 2002, 185-186).

A relatively new sound signal is that of the audible pedestrian signal. Possibly the first such signal was in Portland, Oregon in 1948 (Oliver 1989, 33). However, APS Guide indicates that the first forms were in 1920. But not included in MUTCD in 2000. (APS Guide, 1). However, such signals were not very common until the 1980s. (Oliver 1989, 33). The same author notes that such signals can “emit buzzing, whistling, beeping or chirping sounds." (Oliver 1989, 33). Chime signals have been employed in Portland (Kloos 2001). Many US pedestrian signals have employed buzzers. A buzzing sound is used for one direction with a constant tone in the other direction in some localities. Nagoya Electric Works of Japan supplies many signals in the western US. These give off peep-peep and cuckoo sounds (otherwise termed bird calls). Peep-peep often designates east-west crossings while cuckoos designated north-south crossings. (Oliver 1989, 33-37). A semiotic system has been created through the use of sound. Some signals also employ tactility as a message system: "vibrotactile" devices signal pedestrian movements through touch. (Kuemmel 2000, 42). (*Historical Survey*, 2002,180-181).

Fog Signals for Airplanes? That seems to be a very unlikely possibility yet such an aid existed; though not labelled as a fog signal. The aid was intended to be an aid to blind flying and landing. It was known as the "Sonic Marker Beacon." It was comprised of three whistles (all high-pitch, 3000 cycles) set within megaphones and mounted on an air compressor. The signals could be heard 2000 feet in the air and 700 feet beyond the airport boundary. The individual whistles merged into one signal when a plane was equally between two of the units. The use of radio beacons accompanied by the sonic beacons was viewed as an advance toward blind flying possibilities. (Sonic Marker Beacon SA 1933, 22; *Historical Survey* 2002, 186-187).

Sound signals continue to be employed for aviation. However, the translation of electronic signals into audio (as well as video) energy forms comes at the receiver end and is not a safety aid in itself. Such audio messages receptions can include older aids such as Sonne during and after World War II in which audio messages were in the form of Morse Code signals (Blanchard 1991, 312) and in newer aids including marker beacons (ILS) that create double messages of color light messages and Morse Code messages. (US AIP 1990, Communication, COM 0-9). (*Historical Survey* 2002).

Note on Terminology

It is commonplace to speak of electro-mechanical devices that employ electricity and mechanics in tandem. But this can be confusing since electro-mechanical devices are not only the form to employ mechanical means. To say, for example, that a bell is electro-mechanical because an electrically-programmed impulse drives a striking mechanism against the bell's gong while a bell with a metal plunger which slams against a gong because of an electronic process is electronic rather than electro-mechanical is confusing. That second example is from a manufacturer's catalogue (WBS 1983). The ubiquitous encyclopedia, Wikipedia, supports the WBS approach: Seemingly a device is not electromechanical when it contains microcontroller circuits made up of transistors "and a program to carry out the task through logic" which includes necessary moving parts. (Wikipedia, Electromechanics, 2013). Yet it remains partly mechanical.

There are other examples of safety devices made up of various components and whose label could take one of several of directions. For example, a different device form could create a simulation of a traditional fog sound signal by electronics that would be entirely fully electronic, rather than a mechanical device enhanced by electronics. A second example would be that of an air-powered signal in which a mechanical system creates a movement of air against a reed that creates a sound but whose system is technically is not a direct mechanical process since the source of energy does not directly activate a mechanical system creating a sound.

It may be more accurate to speak of the energy sources and the means of producing messages rather than attempting to determine all of the precise components involved. At the least it would help to avoid a label of T-M by only one component (e.g. a label of electronic when omits other components are omitted).

CHAPTER FIVE

TRANSPORTATION-MARKINGS & DESIGN

5A Design, Culture & T-M

5A1 Introduction

Design may seem a peripheral, if not tangential, topic in a study of Transportation-Markings that centers on the types of markings and their message systems. Yet any object, including that of T-M, is very much bound up with design. Both forms and messages are a product of design. T-M design can be haphazard and unplanned but, nonetheless, it is present. The place of design in these studies has grown from insignificant to prominent over several editions as a brief survey may illustrate.

The original foundational monograph (lst edition, 1981) lacked coverage of design. For a time a separate monograph devoted to design topics had been envisioned. Instead, a single chapter was written on the subject (2nd edition, 1991). That chapter underwent only limited revisions for the 3rd edition. Design in those editions was more a treatment of the shaping of design in T-M than the actual process of design. A major change in that treatment took place in the 4th edition (2005) with the addition of a sub-chapter on design, culture and T-M. Central to the sub-chapter was a primer on T-M and a historical review of design.

The primer includes terminology, design processes and the interaction of design and culture. This primer joins primers on light and color, electronics, and acoustics that appeared in previous additions. The historical review includes the Victorian era and major movements in the 20th century. A variety of design forms are touched upon.

An additional topic in this chapter is that of culture. Culture has had a perhaps elusive and largely hidden place in these studies. In the second edition attention is given to design as a reflection of culture. However, neither definition of culture or explanation how design reflects or otherwise transmits culture is included. The 4th edition (2005) gave more attention to culture but it remained somewhat marginally. The 5th edition (2008) refurbishes the definition of culture, gives greater attention to the topic of material culture and possibly suggests an approximate parity of culture and design.

This edition bears a strong resemblance to that of 2008. A significant change is the updating of sources. While older sources (outside of electronic and related technologies) can be long-lasting the sources for computer-related topics become outdated quite soon. The monograph interweaves sources of information that are both old and new.

This subchapter of 5A is joined by two other subchapters. Chapter 5B, external factors affecting design in T-M, substantially follows the pattern of previous editions; Chapter 5C presents a triplex structure of direct factors affecting design of T-M, the reflection of culture, and message systems and design; 5C follows the pattern of previous editions.

5A2 Primer on Design

a) Terminology

The primary term for this coverage is, of course, Design. Other terms including Fashion, Style and Culture are also reviewed. The terms while few in numbers generate many definitions and descriptions. Definitions may at times appear elusive, and even contradictory, a review of terms may lead to a measure of illumination and clarity.

Design can have diverse definitions, though many can be reduced to a two-level description: Design is both noun and verb. The online encyclopedia *Wikipedia,* notes that [t]he verb is the process of originating and developing a plan for an ... object." While "[t]he noun is either the finalized plan of action or the result of following that plan of action." (Design. Wikipedia 2006). Design can be summed up simply: design is process or product (Lawson 1997, 3; and S & S 1983, 1).

Walker presents a more complex description that includes a four-part explication of design which unfolds the implicit meanings of the noun/verb perspective: "... 'design' causes ambiguities because it has more then one common meaning: it can refer to a process ... or to the result of that process ... or to the products manufactured with the aid of a design ... or to the look or overall pattern of a product." (Walker 1989, 23).

Other approaches for describing design include some that focus on the appearance. Lauer 1990, for example, speaks of "the planned arrangement of elements to form a visual pattern." Since Lauer includes finished products "visual pattern" may suggest more than the visual appearance of a product. (Lauer 1990, 2). Dorothea Malcom 1972 offers a second approach in describing a design as a relating of elements and the creating of a visual arrangement which presents “an interesting unity.” (Malcom 1972, 7).

From a design perspective T-M can be said to focus on a pre-process perspective: the historical factors, materials, and the impact of transportation infrastructures and modes on the process of designing specific T-M forms. The end product and appearance of the forms is a second focus. The coverage of design and T-M in this study does not include details on the actual designing of T-M objects.

The term Fashion is not as central to this study as Design but, nonetheless, it occupies a place of significance. Admittedly Fashion can easily conjure up ephemeral images of the latest fashion creations in New York and Paris. It can also include wider meanings: diverse objects for removed from clothing. An older social science source, IESS, offers a dozen examples of “fashion” ranging from painting to writing, entertainment, various forms of sciences, mathematics (IESS 1968, 5, 342). Walker describes fashion as “many forms of human behavior” though clothes are preeminent. (Walker 1989, 171).

Fashion can be viewed negatively. Wikipedia suggests that “[a] fashion consists of a current (constant change) trend, favoured for frivolous rather than logical or intellectual reasons.” (Fashion. Wikipedia 2004). Fashion can also be viewed more neutrally: “a pattern of change in which certain social forms enjoy temporary acceptance and response;.” changes in “the direction of sensitivity and taste” rather than frivolity alter the direction of fashion (IESS 1968, 5, 341-

342). A more positive view is that of Holly Brubach who sees fashion as reflecting the culture, as providing identity for people. (Brown, salon.com 1999).

A third term, Style, may receive less attention within a design context. By contrast, Walker 1989 manifests such an interest including a definition of style (from Meyer Schapiro): "By style is meant the constant form - and sometimes the constant elements, qualities and expression - in the art of an individual or a group - style is, above all, a system of forms .... ." Walker expands that definition by adding content to form. (Walker 1989, 23).

Style refers to groups of objects rather than a single artifact. An object that is classified as belonging to a style indicates other objects with shared characteristics as well. *New York Magazine* in 1998 devoted an issue to style that questioned whether contemporary culture even has a style: "Modernity has rendered the material world into some kind of plasma that is perpetually prodded and massaged into an endless variety of contours." (Muschamp *NYTM* 1998, 61). Walker doubted the existence of what he termed a "unitary style" by noting ".... what we witness is a plurality of styles, a culture of fragments." (Walker 1989, 157).

Style and fashion have been seen as interchangeable terms. Walker notes that style can be seen as "a mode of fashion" while fashion has a short life span and can be viewed as a fad or vogue. Style, on the other, has longevity and a recognizable character. A fashion appears and then disappears. A style can include the fashionable, but a style can continue even when the content is classified as no longer a fashion.

(Walker 1989, 155, 156).

A different approach to style is found in Ferebee who describes style as “the designer’s language.” The grammer for that language are the elements of design (line, form, etc). (Ferebee 1970, 8). Dormer 1990 speaks of styling rather than style and describes it as “the visual language that says to a culture that it is ordering itself .... productive patterns of work, leisure and institutions.” (Dormer 1990, 19).

The next term, Culture, is a vital term for this study though different from the specific art and design terms considered. Culture is employed more frequently and it also displays a variety of means. The noted anthropologist Alfred Kroeber and associates uncovered nearly 300 definitions of culture, (Seymour-Smith 1986, 65). Reece McGee, influenced by the work of Clyde Kluckholm, defines: “... culture [as] an historically derived system of explicit and implicit designs for living which tends to be shared by all or specifically designated members of a groups or a society.” (McGee 1972, 19, 21, 176). “Designs for living” can be seen as the core of the definition. It refers to learned behavior and includes what people wear, and where they live, the objects they use. Those objects are shaped by the cultural system and reflect that culture. A focus on objects leads to a companion term, Material Culture.

Material Culture includes a vast array of manufactured objects. It includes diverse dimensions of objects: modifications, uses, ways of production, materials employed. Physical objects provide indicators to the operation of cultures and human behavior. (Parezo, ECA 1996, 747). Culture is a symbolic system and cultural features are embedded or embodied in artifacts or objects. (A.A. Berger 1992, 8-9). Objects that inculcate and transmit cultural meaning can include a range of objects: T-M forms as well as architecture, consumer products and much more.

Two additional terms having an impact on design and T-M are minimalism and functionalism. Minimalism can be viewed as a style keynoted by clear form, simple texture and structure and "severity of means ... ." (Strickland 1993, 4). Minimalism includes a variety of arts including the visual (painting, sculpture, dance, film), music, writing. It employs limited resources and reduces detail, extravagant texture and complex structures. (Strickland 1993, 7). The simplicity of minimalism is often displayed through geometric form. The term seemingly is often expanded to other design forms. The term minimal art is more commonplace than that of minimalism. Not infrequently sources that begin with minimalism move to minimal art. A broader use at least of minimal art (and minimal form) is found with McIllhany 1970 who expands it to design of all forms including consumer and industrial forms. Minimalism can be applied to second-skin fabrics and clothing whether highlighted by brevity or of an encompassing character. (Minimalism/Minimal Art internet sources: *Columbia Encyclopedia* 2001 (www.bartleby.com), Wikipedia 2004, artmovements.co.uk, artlex.com. 2004. Print sources: McIlhany 1970, 72-73, NOAD 2001, 1987, Strickland 1993).

Functionalism can be defined as design whose form follows function. This reflects the idea that a designed object's image is dictated by its function. This is reinforced by Louis Sullivan who stated that “form ever follows function.” However, G. Marcus claims Sullivan meant “forms express function” rather than the former. (Marcus 1995, 10-13). Functionalism involves adapting the form to its function and environment. The term was to take on a narrower meaning in the 1930s. (Marcus 1995, 12). Though a broader meaning remains valid. Functionalism, the philosophy undergirding functional design, is a key notion in the 20th century and is important for this study in its more general meaning. (NOAD 2001, 1087, 687; Ferebee 1970, 78; Functionalism. Michl 1997).

Alyson Ward offers a final remark on terms and their relationship. In writing about clothing for the 2004 Olympics she refers to “form, function and fashion” as well as “style, function.” Her bringing together of what may be seen as disparate ideas underlines the vital connections between what can be viewed as the ephemeral with practical and even timeless concepts. That view offers a perspective for this study. (Ward 2004, C6).

b) Elements & Principles of Design

A design project is made up of elements and the way the elements are assembled is dependent on principles of design. The number of elements varies with authors and designers and can include line, value, color, shape and form, texture, space. Principles of design include balance, rhythm, emphasis, unity. The arranging of elements can consist of similar and/or different elements. A unity achieved with an arrangement of elements and principles constitutes a design. (Malcom 1972, 7, 20, 76; S & S 1983, 35; Ballinger 1965, 26-27).

The most frequently employed element is that of the line. A line can be viewed as a recording of movement and defined as "the path of a point moving through space." Designs ranging from graphic symbols to drawings, marks, diagrams employ lines. Lines, in turn, generate space, shape. Lines are not only the starting point of employed elements but may be the only element. The element known as value has reference to gradations of color density. That is, the contrasts of dark and light in varied permutations. Color, a third element can generate variations, combinations. Human emotions, moods can be seen through color in design. (S & S 1983, 35-35-38, 40-43, 45-47).

Other elements include shape, forms, texture, space. Shape refers to a two-dimensional form enclosed through the use of a line (e.g. a circle). Form represents a shape but in a three dimension volume (a sphere as contrasted with a circle in shape; other basic geometric forms include cubes, cones, cylinders, pyramids). Texture refers to surface quality. The composition is indicated by tactile encounter. (Malcom 1972, 64; S & S 1983, 58-60, 69-70). Space has been described as the expanse without bounds that contains all things. The environment of space can accept elements of design previously described from line to texture. (S & S 1983, 69- 70; Ballinger 1965, 26).

Principles of design include balance, rhythm, emphasis, unity movement, contrast. Balance, among the principles, suggests stability; it can take a symmetrical or an asymetrical form. Some forms of design, whether schools or periods, have focusses on symmetrical forms while others have tended toward a less symmetrical balance. (Ballinger

1965, 27). Rhythm employs repetitions in one or other form. These can be continuous, intermittent or display an alter-nationg pattern. Rhythm can also be termed a repetition in which rhythm of design becomes the operational principle. (Malcom 1972, 92; Ballinger 1965, 28). The principle of emphasis includes greater focus on a portion of a specific design through the use of color, line, size, contrast. Unity has been described as a "satisfying sense of relationship" through the use and interrelationship of the various elements employed. (Ballinger 1965, 29).

Movement and contrast are the final principles to be considered. Movement is a technique of the designer that compels the eye movement of the viewer toward the design and to specific dimensions of the design. Malcom 1972 even claims that the designer controls the viewer's eye though the design. (Malcom 1972, 86). Contrast is possibly subsumed into the principle of emphasis. Though it can be seen as a separate principle denoting contrast through changes in density of color or shape, size, texture. (Malcom 1972, 104).

c) T-M, Design & Culture

In 1955 Jame Gibbs (a West Coast maritime historian) remarked that "Conventional lights stations and the present one at [Point] Arguello [CA] are as different as the Gay Nineties bathing suit and the brief Bikini worn by shapely girls today." (Gibbs 1955, 27). James Gibbs touches on an important notion with his informal prose: very divergent designed objects are imprinted by the surrounding culture and reflect that culture with its distinctive cast. Objects tied closely to the immediacy of fashion and objects seemingly immune to the transitory can both be faithful indicators of a given time. Victorian clothing and safety aids are linked through culture-impacted design as are similar products in this time. The opacity, solidity, bulky ornamentation of the Victorian era whether in societal mores or in design practice is reflected in many forms of designs. And the movement toward function, the reducing of opacity, and the increasing of a more minimal attitude, is displayed in the 1950s and into the twentieth-first century whether in society, popular culture or specialized design at the periphery of the mainstream.

Holly Brubach in an inteview offers reflections that expand the idea of the influence of popular culture and design: "Fashion is in fact architecture's feminine counterpart." (www.salon.com 1999; her remarks are based on her book *A Dedicated Follower of Fashion*). Her range of interests may not be all-encompassing but it is possible to extrapolate from her perspective and suggest that all designed objects are components and embodiments of the current culture and times. It may not be easy to say how this process takes place yet it does take place.

Ferebee notes that designers not only bring together the elements that result in a design but also create statements that provide "a key to understanding the culture from which they emerge." It is possible that the designed object emanates from the culture and simultaneously helps to explain that culture. (Ferebee 1970, 8).

The views of Gibbs, Brubach, Ferebee and others have both formally and informally explored the mutual interaction of object and culture. They have thereby influenced, shaped and helped to provide a structure and foundation for this coverage. The focus of this work was the design and interaction of design and culture for T-M phenomenon, the messages they produce and emit and the embedded meaning.

A scholar in cultural anthropology, semiotics, design can disassemble and delineate how cultural factors shape attitudes and objects which thereby become reflectors and indicators of the culture; these can be applied to a specific entity as do the impact of design has an impact on culture. However, in this brief study it may be sufficient to note that T-M is not an isolated monad existing apart from society and culture. On the contrary, it is an active participant in the culture as it creates and propagates a complex information and communication system.

Earlier T-M studies referred to design as a simple reflection of culture. But little was actually said about culture itself and less about the relationship of design and culture. In a 2003 AIGA presentation William Drenttel and Jessica Helfand (Drenttel & Helfand 2003) discussed design and culture and their interaction. Drenttel notes the growth of design since the early 1990s that has resulted in design becoming a ubiquitous component of modern culture. The use of the term culture and awareness of culture has also grown rapidly. The relationship design and culture has grown as well resulting in a complex and difficult to understand character.

In commenting on remarks of an English designer Drenttel asks if design serves as lens into culture, or if culture remains invisible unless filtered through design. He ends with a suggestion that "design=culture" was the underlying meaning of that designer. (Drenttel & Helfand 2003). Perhaps design=culture overstates the reality. Yet there is substantial interaction between design and culture. Design is more than a reflection of culture or a window opening onto culture. Design has an impact on culture as does culture on design. This brings about an intertwined relationship both complex and real. Peggy Sparke in her study of design and culture notes the difficulty of defining those terms yet also notes that both have an impact on each other. (Sparke 2004).

This study began with recognizing that design reflects the culture including a non-consumer entity such as T-M. While this study retains the idea of T-M reflecting culture yet it must be acknowledged that is only a partial description of design and culture and their reaction. The older focus as T-M as reflector is retained in latter portions of this chapter. That is admittedly a partial perspective.

5A3 Capsule History of Design: Victorian Era to the Present

a) Introduction and the Victorian Era

A brief history of design in various forms from the early 19th century to the eve of the 21st century would be a significant challenge to the history of design. A history in capsule form by an amateur is a far greater challenge. However, the effort is needed in order to outline a context for T-M within design and culture. Primary salient features can at least be suggested though perhaps little more is possible. A simple schema of the Victorian Era (to 1901) and the 20th century divided into periods of 1900-1950 and 1951-2000 would be a plausible schema. Yet other formats are possible including the Victorian era (to the late 19th century), Art Noveau (late 19th century/early 20th century), Bauhaus and Art Deco (substantially between the World Wars), and the post-World War II era. The period after World War II lacks a name since no primary theme exists. A composite of those eras is employed here: Victorian Era, Late 19th/Earlier 20th centuries, encompassing three sub-fields, and a post-World War II period.

The Industrial Revolution, with its far-reaching changes, began roughly in the mid-18th century. Changes in design of and making of industrial goods, architectural constructs, clothing and much more was underway by the 1830s with an accelerating quantity of goods and changes in industiral procedures as the century unfolded. (see *T-M Historical Survey* 2002, Ch 1B).

Ferebee terms this development as the "Industrial Age of Design" and notes the accession of Victoria Regina and the manner of producing goods as having occured nearly simultaneously. The time of a products made by hand gradually faded out in the face of machine-produced goods. Mass production of goods depended on two factors: making many parts of the same object simultaneously through the use of machine; and assembly of parts that could be interchanged on an assembly line that moved continously (Ferebee 1970, 34).

The result was more than a simple making of similar or identical products at a faster rate of production. Mass production led to change in design: by making a product's shape simpler it made the making of the product simpler. The simpler form affected style but, perhaps paradoxically, it could develop a complex style of curvature (termed "Picturesque") as well as a simpler style (originally termed Proto-functionalist). However, machine production laid a foundation for "a new machine esthetic" which in time would replace the Picturesque by a Functionalist pattern. (Ferebee 1970, 34-5; *T-M Historical Survey* 2002, Ch. 1B).

In architecture the bifurcated world of Picturesque and Proto-functionalist was also present. The outstanding example of early functionalism is the Crystal Palace, 1851. Its simplicity was due in large part to a prefabrication of parts. (Ferebee 1970, 34-35). The building parts were of a standardized form and in large quantities. (Yarwood in McNeil 1989, 895). Earlier green house (or glasshouse) developments were prototypes for the Crystal Palace. (Dixon and Multhesius 1985, 96-98). The structure was originally termed "styleless" since it lacked neither Greek or Gothic features. The stark geometric design would become recognized as a style in itself. The style of the Crystal Palace was molded by machines; machines also generated new materials. In particular new methods allowed the production of vast quantities of glass. Machines also led to the assembly of the structure: trolleys ran on iron girders allowing a rapid installation of the glass panels. (Ferebee 1970, 34-35). Perhaps curiously this precursor of modern design housed a vast collection of articles mostly of an older and more ornate nature (S & S 1983, 119).

Railway station constructions in London were influenced by the Crystal Palace and other designs. For example, King's Cross Station, especially the train sheds, was so influenced and began construction at about the same time.

It was an even larger structure. But the simple lines of the sheds were masked by a hotel and station fronting the complex. And the masking elements followed an historized design. (Dixon & Multhesius 1985, 96-98).

In summary, the Victorian era became an era of transition from one age to another. That era witnessed the building of a foundation for simpler, more stark styles and a vast system of design and production that would churn out endless objects of amazing and overwhelming variety in the coming century.

b) Late 19th Century & Earlier Twentieth Century

There are three schools, or perhaps more accurately, movements in design between the Victorian era and the contemporary world. Each manifests many complexities in names, meaning, ways of viewing design. The first, Art Noveau, is a kind of transition state and includes the latter part of the era of Queen Victoria and continues on to World War I or nearly so. Following Art Noveau is the starkly functional world of Bauhaus and the more decorative curvature world of Art Deco. The latter movements overlaps both in time and regions. A brief sketch can do little more than names, dates and give a hint of what they represented. But it does present a context for design and T-M.

Art Noveau occupies a period of time in late 19th century and early 20th centuy. It is variously dated between 1880 and 1894, and ends from 1910 to 1914. (Ferebee 1970, 56; Derville 2002; Lampugnani 1986, 19). The name means simply “new art.” The name originated with an art shop in

Paris (1895). (Pile 1990, 16). Art Noveau refers to a series of diverse avant-garde movements. These movements were united in reaction to the academic schools of art and a historical perspective. Art Noveau focussed on outlines (often curved) rather than "surface decoration." (Ferebee 1970, 56). The use of curves often employed a "whiplash S- curve" that suggested botanical plants. (Pile 1990, 16). Art Noveau followed a symbolic aesthetics that represented ideas through natural forms rather than a historic period. It represented more a part of modern design rather than mere decoration. Function influenced form in Art Noveau and in time the Picturesque would fade out in face of functional design. (Ferebee 1970, 56-57).

Bauhaus, which partially overlaps with Art Deco, was organized by Walter Gropius in 1919 and lasted, in its original state only until 1933 when the Nazi regime ended it. Bauhaus recognized the growing importance of industrialization and its impact on design. Materials, processes, technology were all involved in a process of change. Bauhaus viewed control of technology by designers as vital in the light of these changes. Designs by Bauhaus were marked by simplicity, by the use of technology. There was no break between craft and art. The curriculum of Bauhaus called for both designing and the actual constructing of objects including small items such as light fixtures. It was very much a functionalist design. Despite its short life in its original place and time it would have a seminal impact on design extending far and wide and continued to the current time. (Lampugnani 1986, 35-37; S & S 1983, 127-128).

Art Deco is associated with the 1920s and 1930s though at least one source dates it back to 1910. (Art Deco-Kollo 2003). The name is an abbreviated form of title of the Paris Exposition, 1925: "Exposition Internationale des Arts Decoratifs et Industriels Moderne." Art Moderne, a common name for Art Deco is extracted from that label (Art Deco. Kollo 2003). The actual term of Art Deco dates back only to 1968 when coined by Bevis Hillier, a British art historian. (Art Deco.www. Astoriaartdeco. com).

Zimney notes that "industrial" and "modern" (words in the title of the 1925 exposition) describes Art Deco. That exposition "sought to combine the ambitions of the earlier Arts and Craft Movement with industrial technology." (Art Deco. Zimney 1997). Some view Art Deco as having two phases: an earlier and more complex phase character and a later (after the beginnings of the Depression) simpler, unadorned style. (Art Deco. Zimney 1997). Others confine the term Art Deco to the earlier period and the later term Modernist or Streamline Moderne. (Art Deco. Decopix 2000).

Earlier Art Deco included ornamentation employing geometric forms natural styles. By contrast the later version, Streamline in the 1930s, was markedly simple in style. Older versions displayed "abstract, angular, or floral ornamentation" while newer versions were short on ornament and manifested a nearly "machine-like look." (Art Deco. Zimney).

c) Design Since World War II

1) Introduction

One can speak of Victorian or Art Noveau or Art Deco design. But to name a style or design for the post-World War II, and especially recent decades, is no small challenge. Herbert Muschamp in the *New York Times Magazine* noted that "[t]he rules are breaking down. In a frenzy to move product, design is exploding, mutating, multiplying." "There is no dominant style, no prevailing trend." (Muschamp 1998, 61). John Walker, an English scholar, asked the question in the 1980s, "Is there such a unitary style for our own age? Most would answer argue 'no' because what we witness is a plurality of styles, a culture of fragments." (Walker 1989, 157).

A brief review can only be a glance at post-World War II design. It can outline some events, trends without achieving a definitive or comprehensive character. The 60-some year period of time can be divided into two approxi mate segments: general remarks to the mid-1970s, and more specific remarks from the mid-1970s to the early 21st century.

Samuelson & Stoops note both the lack of a school or dominant style of design, as well as the actual key features in the post-World War II era. A major feature of post-war design is from the older Bauhaus movement: The older "prediction of the productive interaction of the designer and the machine" was to come to fruition. Mass-production came to dominate and many new materials became a commonplace. (S & S 1983, 135, 136). These were often synthetics that included plastics (also known as synthetic polymers) including, polyurethane, acylics, polycarbonates and fiberglass

(glass-reinforced plastic). (Plastic. Wikipedia 2004). A second feature in an era lacking a coherent school of design was the role of diversity and individualism. Diversity and the lack of overarching themes would continue and at an accelerating pace. (S & S 1983, 136, 138; *T-M Historical Survey* 2002, Ch 1B).

Design can be looked at from many vantage points resulting in perspectives giving emphasis to different points of significance. Two ideas of significance for this study are minimalism and functionalism; minimalism is the more notable. Minimalis has divergent meanings. It is employed here with a small "m" with the meaning that minimalism can cover many design objects even if in an informal manner.

Sterling McIlany in 1970, in writing of minimal art noted that "minimal form is not the concern of just the avant-garde painter and sculptor. It is a major force in contemporary design that pops up wherever we look." (Mcllany 1970, 72). In contrast to a variety of other writers who begin with and remain with minimal art, he expands it well beyond that. Mcllany includes clothes, architecture, consumer design as well as art. All of these borrow from geometric forms and display a "strong family resemblance to that most severe of all modern minimal shapes: the computer." (Mcllany 1970, 72-73). Mcllany's views continue to contain considerable truth down to the present even though design has greatly changed.

2) Minimalism & Functionalism

Minimalism and ultraminimalist not only denote simplicity but may also suggest a lack of substance, even a lack of coverage of whatever sort. However, a designed object can be entirely covered, even opaque, when the fabric (of whatever substance) is tautly stretched over the underlying form and still constitute minimalism. Dyett in 1993 spoke of minimalist and ultraminimalist activewear clothing and often her examples were garments that entirely enveloped but stretched to a thin membrane of spandex-altered cloth. Such membranes can be termed second-skins. (Dyett 1993, 8A). Minimalism can also refer to reduced covering. In an essay on swimsuit Margaret Visser notes one of the few major fashion changes with the hip-baring swimsuit. This suite substantially uncovered the body below the natural waist. It was a one-piece garment though the earlier two-piece version began the trend. (Visser 1997, 182-183).

Functionalism and form follows function can also be applied to many forms of design throughout much of the 20th century. The terms vary in meaning and, not infrequently, neo-historical forms have become more common in architecture and overshadowed older streamlined buildings and other objects. (Functionalism. Michl 2003; Ferebee 1970, 8). Yet form does follow closely the function of many objects from space craft to computers. In the case of computers functionalism and minimalism have merged for a growing swatch of the computer industry.

3) Cultural Icons

The diversity of designed objects is such that a few forms can hardly represent the culture. Yet objects with the character of cultural icons can represent a larger picture. Cultural icons can be defined as “a person or thing regarded as a representative symbol, especially or movement." (OED in learning.unl.ac.uk). In 1979 *Life* magazine produced an eclectic mixture of designed objects from the previous decade that could be viewed as emblems and totems. It was indeed a diverse collection ranging from water bottles to string bikinis, back packs, designer jeans, soccer balls, food processors. Some, if not many, of the objects could be classified as cultural icons. (*Life*, Time Capsule, 12- 79). The Montreal Museum of Archaeology and History produced a collection of "20 Objects from the 20th Century" and the objects probably could be termed cultural icons as they were viewed as "the objects most representative of the 20th century." (www.musee-pointe. 2001). They include predictable objects such as automobile, airplane, electric light, jeans and less predictable objects such as the plastic garbage bag.

While there are probably many objects that can be termed cultural icons, are there a few objects that are notable for their ubiquity? If reduced to two objects representative of cultural icons one might suggest blue jeans, and computers. Both phenomena are interwoven into the fabric of the US society and no doubt in many others.

A.A. Berger in his treatment of material culture focusses on one object in an examination of fashion: blue jeans (Berger 1992, 7, 8, 13). Trebay terms mainstream jeans (including Levi's, Lee) as "iconic jeans" and that may mean more than they are an icon only for jeans (Trebay 2004, 3C). Louis Sullivan in a book length treatment includes "American Icon" in the title (*Jeans: A Cultural History of an American Icon*). Victoria Everman links jeans to other traditional icons: "Denim, jeans, dungarees ... are an iconic part of American culture, like Chevrolet trucks and apple pie." (Everman 2007).

Blue jeans have ebbed and flowed over a half-century if not longer. Of late they loom up very large on a popular cultural horizon. Denim Glossary a decade ago claimed that over a half-billion pairs of jeans had been solid in the US in a single year in the mid-1990s. (Denim. Denim Glossary 1997). Plain jeans that are relatively cheap (some under $20.00) have been joined by premium jeans (defined as those costing at least $50 by some sources and $75 or $100 by others). There also "superpremium;" these are in the $200 and up range. (Sullivan 2006, 255). Even Jeans costing many hundreds of dollars are not overly uncommon. No matter the brand, means of construction or cachet of exclusivity, jeans have achieved a place in the culture not occupied by any other garment. Few objects of whatever nature can match their cultural icon position.

A second cultural icon may be that of the personal computer. Clunky, room and even building-sized computers of the World War II era evolved into smaller yet still boxy and bulky computers. That contrasts with current sleek and minimalist devices with ever more power. Flat-screen technology reduced monitors and tv screens to a not-far-from non-existent state: a foot or more deep machine is reduced to little more than an inch in some cases. (Fulford 2003; Abbott 2003; What is ... ICT 2004). The "I-Phone" termed "invention of the year by Time magazine, includes a full Apple operating system within a tiny space. A full-power computer can now be held and used in a hand. (Grossmann 2007). A recent Apple product, the "MacBook Air" laptop computer, measures from 0.76 inch down to 0.16 inch in width and weighs three pound. The 2004 iMac G5 displays a 2 inch deep screen (Taylor 2004, Stone 2004). Minimalism and functionalism have nearly reached the vanishing point (Null 2008).

Earlier T-M studies referred to design as a simple reflection of culture. But little was said about culture and less about the relationship of design and culture. In a 2003 AIGA presentation William Drenttel and Jessica Helfand discussed design and culture and their interaction. They noted the growth of design since the early 1990s which resulted in design becoming a universal component of modern culture. The term culture and awareness of culture has also grown rapidly. The relationship of design and culture has also grown resulting in a complex character that may be difficult to understand.

In commenting on remarks of an English designer Drenttel asks if design serves as lens into culture, or if culture remains invisible unless filtered through design. He ends with a suggestion that "design = culture" was the underlying meaning. Perhaps design=culture overstates the reality. Yet there is substantial interaction between design and culture. Design is more than a reflection of culture or a window opening on culture. Design has an impact on culture as does culture on design. This brings about an intertwined relationship both complex and real. Peggy Sparke (Sparke 2004) in her study of design and culture notes the difficulty of defining those terms yet also notes that both have an impact on each other.

This study began with recognizing that design reflects the culture including a non-consumer entity such as T-M.

While this study retains the idea of T-M reflecting yet it must be acknowledged that it is only a partial description of design and culture and their reaction.

Individual computers became part of networks and then with the internet a vast interconnected information system spanning the globe was created. A small brown, or off-white box slice of technology has permeated the culture in a way and to a degree unprecedented. The culture has been so altered by that technology in ways both positive and negative that a pre-computer and web-world may be difficult to remember. (Computer History. knobblycrab.co.uk; Stephen 2004).

If a hint of the design and style of an age can be seen through a few widely used designed objects then perhaps a window can be opened on an age through materials commonly in use. No current material can sum up as, say, iron in a previous age (e.g., “The Age of Iron”). But perhaps some materials can suggest concerns and foci of the time. There are obviously many materials in use from traditional iron to plastics. In the 20th century -- and especially since World War II -- the petroleum industry looms up very large from propelling motor vehicles to global warming to producing the raw stuff of many products. Many of these products are petroleum-based synthetic polymers or plastics. A key product was the development of Lycra. A brief review of plastics follows in Chapter 5B.

Lycra spandex (also known as elastophane) was invented by Dupont in 1959. (Reisch. CENEAR 1999). It was originally employed for foundation garments but it spread to athletic clothing in the late 1960s and 1970s. Since then it has become an ubiquitous product that finds usage in automobiles, clothing, furniture, shoes and a growing list of other products. (Kelly 2004; Lycra. Free Dictionary). It is interwoven with fabrics of all kinds including denim, leather and even salmon skin leather (www.Skinilondon.com). Reisch remarks that “[i]ts elastic properties allow spandex to be a fiber now uncorseted by convention.” (Reisch. CENEAR).

Links between denim and Lycra grew with the Invista announcement of “XFIT” Lycra fabric in 2006. The new fabric uses a cross wave technology that permits stretching in four ways. Xfit increases fit and comfort of denim products as well as other fabrics. (www.lycra.com ... press release 2007; Textile World, 2006; White 2006). While Lycra is one product in one industry it has taken on a character of ubiquity and can be said to have become a cultural icon in its own right.

The complexity and diversity of design, designers and designed objects in the past 60 or so years prevents a simple summing up of the subjects. A few key concepts, several iconic products and the materials that make up many objects may at least hint at the character of design, the culture and their mutual impact. Change and development in the larger culture can suggest a context for T-M forms and messages as well.

5B External Factors Affecting T-M Design

5B1 Introduction for 5B & 5C

The workings out of design in T-M has several dimensions. They are considered in Chapter 5A along with culture and other factors. The dimensions include:

1) There is a historical process at work. The current design of T-M forms often have Victorian and Edwardian antecedents (5B2).
2) Design is affected by science and technology. The materials employed in T-M forms have a direct bearing on design; design has an impact on the materials as well. (5B3).
3) The requirements of modes of transportation display design influences. And the routeways and environs on/in which those modes operate are both designed and influence design. (5C1 a)).
4) Design is shaped by the internal requirements of T-M. (5C1 b)).

Further dimensions include:

5) The given characteristics of T-M are the result of the various aspects of design interwoven with the previously mentioned factors. Design concepts such as minimalism and form follows function can be applied to T-M forms having an utilitarian character marked by simplicity. (5C2).
6) Designed objects do not exist in isolation: any object reflects its times (the social, economic, and cultural themes and values of an era). T-M is no exception even though far removed from “fashion.” T-M can be seen to mirror the eras

of its development and, in turn, the eras are reflected in the marking (5C2 b). 5A also noted that design-culture continuum operates in both directions: design reflects culture but culture is affected by design. The older coverage of T-M reflecting culture is retained here though it is the entire coverage in this edition.

7) These remarks are primarily directed at T-M in its physical forms; the comments are less directed at T-M message systems. However, the employment of graphic, geometric, and alphanumeric symbols are also part of the design and require review. The use of color, the way energy sources are arrnanged (light phase characteristics, electronic pulses, etc), the positions of markings (the order of signal lamps in a signal, the movement of a switch signal exhibiting a target, etc) are part of design even if in a less tangible and more elusive sense (5C3 a)-c)).

References are limited in 5B and 5C. Many of the materials are from the several modal monographs of this Series; those sources include extensive notes. Part J, *Transportation-Markings: A Historical Survey, 1750-2000*, (2002) also supplies information on the Industrial Revolution (s) and development of T-M forms. See also Databases Studies.

5B2 The Historical Process

The 19th century was a time of movement of peoples from agricultural and rural locales to industrial sites and urban areas (though the rural world was not eclipsed until relatively recent times). This migration was accompanied by a change from simple tools, primitive industry and small-scale operations to increasingly complex and larger scale production. Immobility for most people gradually changed to mobility as more rapid means of transportation were created, and became available. Rapid changes in transportation were paralled in communications: the semaphoric message systems of 18th century France was supplanted by the telegraph which, in turn, was supplemented by the telephone and much more. With the passage of time limited changes became rapid changes.

Individual cultures were altered in the process of change as connections between cultures were created especially through the establishment of sea-lanes and the movement of ideas and then political domination via those sea-routes. Eventually railway systems were established in many regions often by a few industrialized states that further broke down cultural and political differences though often for the benefit of only a few. Some movements toward a global community was initiated, and ideas of style, architecture, engineering and other forms of design, usually of European and US origins, fanned out and became adopted/ adapted by other nations. To a considerable degree English ideas and technologies were in the forefront of exported ideas and these had a disproportionate impact in many parts of the world.

It was in this changing world that modern T-M forms were developed. The designs and building of these markings can be clearly seen in the expansion of lighthouses and railway semaphore signals. The great sea-girt and coast light towers became increasingly prominent from the later 18th century on. Those lights, through expansion of technology and transportation, moved outward to yet more difficult sites in home waters than to sea-lanes and coastlines around the globe.

Many of these lights were of British provenance (English and Scottish designs may display differences though it would seem that British lighthouse design reflects an actual design and engineering genre) and are quickly recognized as such (for example, the shape of the lantern house is a distinctive design that is often repeated; variations of that design do not greatly obscure its character). The basic design was replicated wherever the British went: India, British Columbia, West Indies, Australia, South Africa. It would be simplistic to suggest that the Stevenson family and the Chance company (engineers and makers of lighthouse equipment) shaped Victorian lighthouse globally. Other firms in Britain, France (including Chappe Brothers), and other nations were also crafting lenses and towers. But a few English firms imprinted marine markings with an easily recognized design.

The expansion of railway signals demonstrates a similar pattern though a less dramatic visage. English semaphores with their long, rectangular-shaped arms and two color spectacles and mast ornaments (based on English engineering and technology, culture and concepts of railway operations and safety) found use from England to South Africa, from New Zealand to Latin America. However, the design of the shape has permanently etched an image of railway signals globally. The US form (often a three-lens form with a tapered blade) while less universal, presents a design found in the Americas, Australia, and even in England. It also represents a design that, once established, never greatly varied. Both models are a cultural-technological-transportation-and-communication assemblage translated into a design.

There is also a third semaphore design of some note: the Germanic or Central European form with rectangular-shaped blades “topped off” with an oval at the outer end; lamp units are separate from the blades. This design is found not only in central and eastern Europe but in some locales in Africa and Asia. Variations of this design have expanded its use.

The connection between forms of design whether “fashion” or T-M can be seen in a photographer in the files of this writer that shows a “flapper” hanging onto an early traffic signal. The two images seem to belong together; they mesh rather than clash. Traffic signals have not drastically changed but the nuances of the design, the structural supports, the use of words embossed on the lens all date that signal to the 1920s as much as the flapper garb dates the flapper as from the 1920s.

5B3 Science & Technology’s Impact on T-M Materials & Design

A survey of how science and technology affected T-M could easily list many science and technology changes of the 19th and 20th centuries. It is more feasible to indicate changes more directly involved with T-M and their design. This review begins with the Victorian era, and continues with more recent decades.

A signficant characteristic of the Victorian era is the availability of iron. This is especially true of that latter phase of the Second Industrial Revolution. The development of iron production affects much of the 19th century including the building of ships and locomotives, the making of railway tracks, the construction of bridges. Iron's availability is also equally important for T-M. Iron buoys greatly expanded the use of floating aids and vastly improved the durability and range of buoys. Older buoys were general of wood construction and while some would continue in use their numbers would be much reduced. Iron buoys also made possible the addition of fog signal mechanisms and eventually lighted mechanisms.

Iron also affected the building of fixed lights and fixed fog signals. Optical changes -- especially the Fresnel lens -- radically altered not only major coast lights but also the light apparatus of many other transportation-markings. New fuels increased the efficiency of lights (including incandescent-oil and acetylene). Automation began in the Edwardian era with the sun valve, a predecessor of the photo-electric cell. Other changes related to increased production of glass for signal lenses and a much greater ability to produce unvarying standards for glass.

All of these changes affected design: new forms of markings required design work; new materials increased the sophistication of existing forms of markings, and greater flexibility in designing and constructing markings transformed T-M.

A review of changes in the 20th century that have an impact on T-M could be all but overwhelming since there has been a virtual explosion of basic and applied science and technology in that century; even a simple listing of change would be prohibitive. The following review, while tending toward the random and eclectic, suggests areas of changes in T-M that are linked to a design perspective.

The advent of the computer has greatly affected nearly all aspects of the culture including T-M. While the impact is significant how much of it has been direct? The internal workings of many markings have been altered, and entire systems of markings have been organized and controlled with computers. Yet the actual messages and meanings has not greatly changed because of computers; most changes have been indirect. However, there are instances of a more direct role in some forms of T-M. For example, advanced railroad control systems employ computer systems that directly affect message systems.

The impact of radio has been far more direct. Beginning with radiobeacons in the 1920s, the use of electronic markings has been increasingly important. Medium and long range marine markings and many aero markings (including short-range aids at airports), have become a major force and frequently eclipses visual and sound aids. Electronics has had great impact on markings and message production and emission has been at least as significant. Electronic markings as well as the replacement of electro-mechanical inner workings by microprocessors have both altered the design process.

Mettallurgical changes of significance include: steel has largely replaced iron; alminum and stainless steel have taken on major roles in T-M. Welding has replaced rivets in metal assemblies in many cases; in other cases structural steel and bolts have been employed. The design process has been altered along with changes in metals and methods of assembly.

A key change directly altering many forms of T-M from traffic signs to complex light mechanisms is the use of plastics. This product has become a nearly ubiquitious and seemingly ephemeral object in that its role in markings is nearly hidden since it can be confused with glass, fiberglass, paint, fabrics, paper. As a result the direct role of plastic can be easily overlooked.

Plastics, in the true sense of the word, began in the early 20th century. The first true was “Bakelite” or phenolic invented before World War I. After that war polystrene (employed in stryofoam) and polyvinyl chloride (pvc; used in pipes and much more) were developed. The invention of nylon or polyamide was to have enormous impact. The 1930s saw the development of acrylic, polyethylene and polyurethane. The last name product had two forms: a blown form and a non-blown version. The second form led to lycra spandex.

The use of plastics in T-M has become ever more vital and widespread. The flexibility of plastics in extrusion processes, in liquid forms, and in maleable units has had enormous impact on the design of T-M including housings, supports, backup structures. Acrylics have been molded into sophisticated lenses that efficiently emit messages for marine aids; they have proved durable even in harsh marine climates. Cellulose acetates (based on a natural polymer) have been widely employed for signal lenses and polycarbonates have been utilized for reflective materials. Urethanes in a liquid state have been applied to signs and pavement markings. The range of plastics, or petroleum-based synthetic polymers are found across the length and breadth of T-M. The form of present and future markings will also be substantial users. Schwartz 1982 and Wikipedia 2004 and 2007 provide discussions of plastic and their developments.

5C T-M & Design

5C1 Interaction of T-M & Infrastructures with Design

a) The Impact of Transportation Routeways on the Design of T-M Forms

Transportation routeways can be examined apart from the design of Transportation-Markings. Even though they are not a direct and immediate component of design they are an influence in the shaping of the direction and contents of that process. Routeways can be divided into two general categories: 1) precise limits, and 2) flexible limits. Mode-specific routeway forms manifest nuanced permutations.

Rail routeways are sharply defined and admit of little flexibility (encapsulated in the title of the now defunct Canadian Institute of Guided Ground Transport, Queen's University, Ontario). Limited flexibility is found at junctures with other tracks. This characteristic of rigidity is reflected in the markings and their design since the marking forms are of a signal type (contrasted with the beacon type). Railway signals regulate relationships between units of a mode of transportation rather than between environment-mode relationships, or a composite pattern of the intra-mode and environment-mode forms. Signs and non-sign markings though of a different nature, reflect these factors as well.

Road routeways are somewhat similar to those of rail though less rigid. These routeways are structure and delineated yet allow for some variations. Intra-modal relationships are a vital element of road markings. Both interaction between modes of transportation and between route-way and terrain are more important than in rail. Road signals are rarely multi-directional though uni-directional signals often share a single installation site and are integrated with adjoining units. The design of signals reflect the nature of route ways, the style of signal and the underlying terrain. Signs and road markings, to some degree, reflect this situation.

Aero routeways bear a partial resemblance to road characteristics and a partial resemblance to marine routeways. At airports the constraints on modes of transportation are similar to those of roadways, while away from airport routewas are abstract constructs with very limited physical boundaries. At airports the direct of movement is nearly always one way, and lighted and unlighted aids are designed and constructed within narrow parameters.

Marine routeways, though marked by flexibility, manifest some structure within boundaries. Channels are marked for inland waters, and charts -- though not markings in themselves -- denote routes offshore. The surrounding terrain, admittedly of a waterly form, is a major factor for the marine mode, and more significant than terrain associated with other modes of transportation (physical geography is vital for other forms but either less immediate or more easily altered than for marine navigation). Many marine aids are omnidirectional and this befits their role as indicators of channel boundaries and of objects. Range lights and daymarks are narrowly focussed and bear resemblance to signals (though the nature of marine forms are beacons not signals in nature).

b) Influence of T-M Internal Requirements on Design

The T-M can be likened to a many faceted prism with each additional prism manifesting some of the facets that refer to design. This has an elusive focus not easily captured. How does the “withinness” of a T-M form affect design is a core question for understanding design.

What does a marking need to create a message and then to project it? Considering the diversity of T-M forms there can be no short answer and a detailed answer can become hamstrung with the details of diverse forms of markings. For lighted forms there is a need for a power source, lamp, lenses, and a mechanism for creating messages of a standardized form which are easily and quickly recognized.

For traditional coastal lighthouses the structure, lamp, lamp housing could and often did result in a large and massive structure. Technology was relatively primitive, the lantern house, mechanism (clock work device, lens, burner, wicks, etc) were large, and the power source (liquid or vaporized fuels) required on-going direct human attention. The creation and projection of the message was not hampered by the size of the structure or by the equipment or the need for frequent attention. The design of a traditional lighthouse was, however, affected by the technology, scale of operations and human presence.

Older harbor and river marine lights, while partially standardized, often displayed a notable degree of individuality: a custom-made (or at least on-site assembly) structure, a self-contained lantern of a traditional form of cast iron, glass panels and requiring frequent maintenance. Daily care could include adding of fuel, and lighting of the lantern. Newer major marine lights may be constructed of structural light apparatus (often of aero origins), computerized and automated, requiring little human attention. And smaller lights often consist of pre-assembled daymarks (including large, easily-read identification numbers), pre-fabricated structures, a long term fuel source, factory assembled acrylic lens with bulb changer.

The resulting design requirements for these new lights are substantially different from older forms. Contemporary design is carried out in a factory or a marine aid to navigation base with only pre-arranged assembly in the field.

Railway signals, whether of older or new vintage, presents a different problem: the signals must be positioned near the routeway and therefore the size of these signals must be relatively small. Older forms were not of powerful intensity because the equipment was not large enough and could not be sufficiently enlarged because of space limitations. By contrast, lighthouses could be powerful even with early technology because space restrictions were less of an impediment. Railway signal mechanisms contained several lenses and the necessary devices for illuminating and darkening the lamps in turn. The technical needs and locational requirements strongly influenced the design factor. This is also true of marine and other markings as well. The height of railway signals was also determined within narrow specifications.

Road signals, though not as confined to locational factors as rail signals, are required to produce a series of alternating messages in close proximity to routeways and to do so without interfering with traffic movements. Lens size, housing, mechanical and optical equipment and installation are established within narrow limits and design is shaped by those factors. Changing traffic, engineering and safety perceptions called for larger lenses, at least for red lenses, yet space considerations were little changed. The addition of optically-programmed signals with precisely focussed single-lane visibility also affects design.

Aero lights are subject to severe restrictions: these lights operate in a tiny area virtually in the path of the aircraft. If lights are set into the pavement the supporting structure must be very strong and if above ground the structure must contain a substantial degree of frangibility (the ability to snap off when hit). Aero lights often display a single color of a fixed character and this simplifies engineering and design needs. Aero lights then, must be small, possess an ability to be demolished (when struck) when above ground though still of durable construction (this contrasts with marine lights which must be able to resist environmental challenges such as turbulent seas).

Design requirements for other markings may be different yet some of the aforementioned requirements are present: clarity and simplicity of message, an agreed-upon message, a more pronounced (in contrast to older forms) pre-assembly/pre-installation character, an increase in simple, graphic symbols and few word messages.

In summary, each form of T-M has internal requirements that affect design. Internal needs are accompanied by the age of the marking, the mode of transportation, routeway, and nature of the marking.

c) Summary of Factors Affecting the Creating of T-M Characteristics & Design

Major factors involved with T-M design include historical process, cultural influences, science and technology, the impact of the modes of transportation, and the internal requirements of T-M forms. That is not the end of the process. Messages (designed objects in themselves) affect the design of markings. Cross-fertilization of factors as well as the chronological changes add to the complexity and affect the composition of T-M configurations and design.

Cultural factors have both past and present dimensions. A T-M form is a reflection of a cultural, but it also part of past markings which, in turn, were affected by its cultural matrix. This is also true of science and technology which have a past as well as a present. And science and technology has an impact on past markings and influences the design of present markings.

This past and present character affects all aspects of older markings including routeways, modes of transportation, and the internal requirements of markings. What is the import of these interacting factors? They create a dynamic that generates a multi-faceted interaction affecting all other T-M forms, their design, and their message systems. This dynamic takes place despite differences how a marking was created (the design, building, activation) and which factors were at play and to what extent.

As an example, a quintessential Victorian sea-girt light tower produced by eminent Victorians employing the science, technology, and engineering of that era -- and reflecting the cultural values of that era -- creates a marking and message system that becomes part of an interconnected system of T-M communication system. That safety aid affects other parts of that larger system both in the Victorian era and thereafter.

No element is lost, no factor fails to affect other markings. Perhaps the effect is tangential/peripheral/marginal and all but invisible. Yet all future markings of whatever sort cannot escape, to use the previous examples, the influence and the impact of relatively primitive lighthouses on the coast of Scotland with their great stone towers, cast iron lantern houses, massive jewel-like lenses, brass clock work mechanism, whale oil fired burner and ephemeral wicks under the close watch of a lightkeeper.

It would be difficult to dissect a marking and say, for example, that factor "x" such-and-such degree of influence, came from markings "A" or "B" or "C." There are examples in which the influence of one T-M form has a close and visible impact on seemingly unrelated markings. For example, at one time railway signal makers manufactured traffic signals, early airway beacons were termed “aeriel lighthouses,” and many older marine range lights were manufactured by railway signal works. But it is of little consequences how shrouded in the mists of the past T-M influences may be, the impact of one marking and its design upon another marking is present.

5C2 T-M as a Reflection of Culture

a) Historical Backdrop

More recent material of this chapter note the mutual interaction of design and culture. Older material focusses on a narrower view of T-M as a reflection of culture without examing a more balanced mutual interaction. These older reflections are retained here while taking note of the newer perspective.

These reflections cover a lengthly period of time, include diverse topics and focus on what is not entirely tangible and can be elusive. The central tenent of these remarks is that the T-M does not exist in a vacuum; that it is part of the culture in which it is found and, in some sense, it is a reflection of that culture. That reflection is seen mostly through the medium of design: the design of the structure that makes up a marking, the design of the actual marking creating and producing the faculty, and the design of the messages emitted.

The way that T-M is a reflection of a culture depends on several factors including specific cultural values, attitudes and social constructs and other influences including historical and technological factors. Marine and rail T-M forms were reflections of the Victorian are and important dimensions of those reflections have carried over into the present. The cultural currents of the age that were reflected may have been outside mainstream characteristics since marine and rail signals were allied with engineering and its more functional approach. This was in contrast to many architectural and other Victorian design forms.

If cultural reflections were peripheral and atypical in some ways they occupied the mainstream in other ways. For example, T-M forms are very Victorian in their solidity and permanence and thereby reflect mainstream values and constructs of that culture. This is truer of marine aids to navigation than of railway signals. One can speak of this topic only in general terms since there are major cultural differences between the 19th century and contemporary periods as well as sub-periods within those eras.

In more recent times T-M forms more often react mainstream attitudes. These include increased development of minimalism, of form following function (and a variant type: form following efficient usage which is not necessarily the same), a non-permanence of structure (though not neccesarily of the "throw-away" sort), the use of more sophisticated materials (acrylics and other petroleum-based products, aluminum, steel, stainless steel contrasted with a decrease in use of glass and of cast iron), change of operational processes (microprocessors instead of electro-mechanical devices), and employment of simpler and bolder graphics and other symbols.

Themes of functionality and practicality permeate T-M and thereby contribute to a certain timelessness and a not easily-dated quality to T-M. These themes lead to a simplic-ity and a focus on basic designs for message systems. This observation can be amplified by a passage from Part F, *International Railway Signals*, on the dual theme of a superficial out-of-date appearance of signals and an actual timelessness of signals. This theme has application to other forms of markings as well. This passage reads in part:

> The railway signal in many of its forms appears very dated; a prime example of low technology, more than a little quaint, and a frequent reminder of the Victorian and Edwardian eras and all the image they may conjure up. Microprocessors and electronic train control add a patina of modernity to the great assemblage of visual signals but no more than that. Despite some modernizing inroads, many signals -- at least in design -- are little changed from the 19th and early 20th centuries; many other signals follow designs that are derivatives of the early signals.
>
> In many instances signals do not, upon close inspection, manifest an outdated appearance. Often they are marked by a stark simplicity; they represent a visual fusing of form and function into one dimension. They are notable example of minimalism accentuating clean and unencumbered lines.

Simplicity, function-inspired form and minimalism contradicts neo-traditionalist design especially in architecture of both the late 19th and 20th centuries. Yet many other forms of design also exhibit those characteristics found in signal design including transportation equipment, communication technology, running/biking/aerobics gear with their "second skin" look. Much of contemporary design has not swerved from simplicity and functionalism and may have focussed more strongly on characteristics.

If one separates the signal in itself from railway transportation that can appear archaic and no longer a trend-setter, then it may be possible to view the signal as an object that follows a timeless path of simple geometric shapes, economical usage of materials and which excludes superficial and useless decoration. This signal parallels not only contemporary design but that of past eras as well. The signal is then part of the present and and not a musty anachronism of the past.

b) T-M: A Reflection of its Times

A complex social and cultural process creates themes that can pervade many aspects of a culture. This process is often manifested through design with science and technology playing major roles. This compiler lacks the expertize to fully examine how this process works. But at the minimum it is possible to list areas where the process is to be found: the jargon, consumer icons and totems, art forms, social group characteristics, attitudes and more in a culture especially at popular levels. More abstract concepts may also be present including the aforementioned one of minimalism and form following function. Contemporary cultures can be concretely images though personal computers, appliances, motor vehicles, atheletic gear, clothing (e.g. blue jeans), and especially the shape, materials, color and graphic symbol dimensions of those objects.

Peripheral areas (or at least areas outside of the mainstream of life and though) can also be affected by this cultural process. T-M is one such area through which the cultural process can be seen at work even if T-M forms can be viewed as esoteric.

T-M role as a culturally-reflective object is largely accomplished in and through design. Design may have been a largely informal and individualized field at one time. It was to be found with architecture, engineering, the crafts movement and perhaps in the making of goods even when not consciously thought as design. But now design schools, professional associations and the students of those schools and members of those associations influence and even "cross-pollinate" one another so that design processes in one field are not immune to what takes place in even far-removed disciplines.

Earlier T-M was described as peripheral within the larger cultural area. It can also be noted that from within the perspective of semiotics and communications T-M is a core element of the culture. It thereby provides a critical reflection of the times. The framework for T-M is to be found within the perspective of semiotics and communications. Core and peripheral dimensions are both necessary in a cultural dialetic for T-M.

Science and technology need to be included as elements in creating a culturally-reflective object. Science research even in esoteric subjects can be applied to diverse applications. Space and computer science studies do not remain in outer space or in laboratories. They move into and through a culture. Research in a single area such as petroleum applications not only is found in consumer products such as athletic gear but also as lenses for T-M forms. Science and technology applications become intertwined with design in a specialized field and an interpenetration of those elements becomes intertwined with culture and a reflector of culture such as T-M.

Minimalism, second-skin and form following function are terms applied to various areas of design (contemporary architecture perhaps less so since numerous design have seemingly entered a "post-modern" period that often incorporates older styles). These terms can be social constructs and technology that precluded a fully functional design in the Victoria era.

T-M follows logical and empirical considerations that result in designs focussing on what is necessary to project the message. Little thought is given to "style" or "fashion." Newer markings more strongly exemplify minimalism and related concepts (though the terms employed in this study may not have been actually employed). Starkness, economy, boldness and the physical minimum are very much attributes of T-M design.

In more than a few instances a modern lighted T-M form, to cite one form, is little more than the modern lens, operating mechanism, and a housing that fits snugly about the less and its inner mechanism, and held up by a sparse support structure. An example would be the Humboldt Bay Light near Eureka, California. The Light consists of a single, vertical pole holding up a very small but high powered lantern (originally intended for aero beacons but now employed for major US Coast Guard installations) that is almost a pure light form; any increase in minimalism would negate the existence of the light.

What are some of the features of modern T-M design that reflect a culture? Major features include a movement from permanence to a more ephemeral existence in structures; messages are larger, bolder and simpler; systems are more evidence as markings are more often grouped together. Minimalism as a major theme for T-M design was described earlier.

Older T-M forms were often of a more permanent nature and marked by a solid and opaque appearance than contemporary models. This is more true of marine aids to navigation and less so for railway signals. Older aids to navigation were often customized; this is true of coastal lighthouses but it partially applies to “minor” lights built by hand even if from existing blueprints.

With the passage of time many T-M forms became mass-produced (even some coastal lighthouses have been factory products which were then installed on site; the late Willapa Bay Light on the Washington State coast (US) consisted for a time of a pre-assembled structure from AGA (now Pharos Marine [Parsons USCG 1986]). Both components and even entire markings are interchangeable in many cases which can be "uprooted" and moved to other sites. New materials and construction methods lead to a situation in which there is less brick, stone, and cast iron and more steel and aluminum. There are also fewer rivets, more welding, and less complex glass assemblies and more acrylic. Less electro-mechanical devices and more computers are also a hallmark of newer T-M forms.

Messages have become bolder and simpler for many T-M forms. This has meant that lenses for traffic signals are often larger, and wordy messages have been replaced by simple, stark graphics (whose meaning, however, may not be any easier to dicipher and decode. In fact, the meaning may be more difficult to unravel). Numbers and daymarks (marine) are much more common and standardized; newer daymarks not infrequently obscure the formerly visible structure. These practices reflect the graphics, use of colors and a more uncluttered design reflection of the larger society.

The design of T-M forms, both structures and message systems, has been undergirded by cultural characteristics that may affect the design process. For an older period of time many markings were individualized and even customized. This was true not only of experimental markings but of more established forms. For the modern period mass-produced objects based on standardized designs is a hallmark of the culture and of T-M.

Systems are also a contemporary watchword: entire groups of T-M forms, even on a global scale, follow set patterns in message systems. Both design and construction of these markings is precisely conceived and carried out. This is in contrast to the older system of US marine aids to navigation which did not fully incorporate river and harbor lights and daybeacons into the buoyage system. As a result many lights were nearly independent agents denoting a point, channel edge, etc. even if in close proximity to a system of buoys marking same body of water. But in recent years, especially with the advent of the IALA system, nearly all non-coastal aids are incorporated into a close-knit and all encompassing system of position, location, color and other symbols.

5C3 Message Systems & Design: Transportation-Markings as Communication

a) Introduction & Terminology

Design has an impact on all aspects of T-M messages both directly and through ancillary forms. For example, the physical support structure of a traditional lighthouse has a direct bearing on the message capability (though the lamp remains of first importance). The signal mast and ladder for a railway semaphore signal (though further removed from the core message than is the structure for a lighthouse) is, nonetheless, part of the message configuration since the “non-message” sihouette of mast and ladder in itself denotes an upcoming message. Even though the specific message can not be deciphered at a distance. This means that the design of any part of a message-producing facility is also part of the design of the message system. The structure can be secondary or indirect or peripheral but, nonetheless, it communicates some portion of a message.

Design, of course, can directly affect the explicit and immediate dimensions of T-M messages. In these instances the role of design is specific and deliberate; not accidental, tangential or vaguely suggestive. All T-M messages include design in this sense though it may be clearer in some cases than in others. T-M messages, no matter what form they may take, have a design dimension. The design of messages can exhibit many forms; a road sign of geometric shape with graphic symbols, the flash of a marine light with its individualized pattern of light and dark, or the pulses of an aero electronic aid.

The greater part of this segment reviews the design of messages in a strict and explicit manner. These messages center on graphic, geometric and alphanumeric shapes. This review also examines acoustical, lighted visual, and electronic message configurations.

Terminology can be problematic and the “rough and ready” definitions of this study may not measure up to more exacting standards. The subdivision of design into graphic, geometric and alphanumeric symbols may be seen as questionable since all of these symbols are typically seen as graphic symbols. For example, Rudolph Modley in his *Handbook of Pictorial Symbols* (1976) speaks of graphic symbols as having three forms: a) pictorial iconic; b) image-related; and c) abstract or arbitrary (the final form includes the alphanumeric). This schema includes three forms of graphic symbols rather than three or more forms of visual symbols. But this compiler, after acquaintance with various T-M forms, nonetheless, sees merit in regarding the characteristics of these symbol forms as denoting a differentiation within the forms. There are, in short, several basic groups of symbols rather than one group with sub-forms within it.

b) Graphic, Geometric & Alphanumeric Symbol Designs

Graphic symbol designs in this study include all designs whether abstract or representational, except recognized geometric shapes and alphanumeric forms. Graphic symbols include actual objects (e.g., arrows), representations of recognized objects (e.g., bridges, railway tracks), abstract symbols created for a specific message (e.g., a diagonal bar superimposed on a dune buggy in a sand dune).

Geometric symbols include simple and unadorned shapes from geometry: circles, diamonds, eclipses, obrotunds, obrounds, octagons, ovals, pentagons, rectangles, squares, and triangles.

Alphanumeric symbols include letters and/or numbers. Letters can be in either word or non-word forms. Alphanumeric forms represent a complex topic since all forms of T-M include some alphanumeric forms though variations are substantial. Marine markings employs numbers for markings in buoyage and beaconage systems; letters are employed in identifying some aids. Aero markings include letter and/or number designations for runways and taxiways. Railway systems employ words for various signs (e.g., station signs, and numbers as well (e.g., whistleposts). Some targets also display letters and/or numbers.

Traffic Control Devices employ by far the largest number of alphanumeric symbols: mileage indications, place names, exit indications, some warnings and construction signs, and even some pavement markings. Graphic symbols have increased at the expense of word symbols though the alphanumeric form remains a strong element.

In many instances the actual symbols are composites of two or even all of these forms. The use of color extends this complexity further. The place of color in the design equation is more difficult to determine. Color may be part of the parent design form (geometric, graphic or alphanumeric) or color (since it has a form in itself) may be related more closely to graphic design.

c) Visual, Acoustical & Electronic Message Configurations

The forms of energy (electromagnetic and sound) when applied to T-M can exist in either modulated or non-modulated states (modulated: altering the flow of energy by changing the frequency or by some other type of interruption). Configurations refer to interruptions or alterations of a flow of energy into recognized patterns of messages. There is a design principle at work in the creation of these configurations. Configurations of messages as they are found in visual, acoustical, and electronic T-M forms are reviewed here.

Light, at a basic level, presents a specific color or

wavelength of electromagnetic energy. A first-level modulation would be a turning on and off of the facility of generating of visual electromagnetic energy. This first-level modulation is sufficient for creating flashes. However, more can be done to create different messages than a creating of simple flashes. Flashing, in specific terms, refers to a pattern in which periods of darkness are greater than the periods of light. Occulting patterns present a reverse situation: light periods are greater than those of dark while isophase (equal-interval patterns) display equal portions of light and dark.
T-M forms can display a single, unvarying pattern of messages though multiple levels of flashes (e.g., a railway system employing a pattern of slower and faster flashes).

Flash patterns can take on many diverse and complex patterns: marine aids to navigation agencies provide a broad range of categories (group flashing, and quick flashing among others) and a wide range of specific characteristics are possible within a category (e.g., a marine light displaying a flash every five seconds: Fl W., 5s [W=white]). Occulting patterns also include several categories with the resulting individual characteristics.

Fixed patterns can take one of several forms: a single color light in marine systems, a series of fixed color lights in aero situations, a series of fixed but alternating lights (in several colors), in road and rail usage and a variety of other forms (fixed and flashing, fixed with graphic symbols, etc.).

In summary, the message design process begins with a unit of visually perceived electromagnetic radiation followed by a design modulation resulting in one of many possibilities.

Some of the possibilities are basic patterns that extend through a mode of T-M, or at least a specific system; other patterns are designed for a single marking.

Sound waves can also be modulated though the process is at variance with those of light energy because it represents a different form of energy. In many instances sound waves do not undergo a design process (though one can argue that the design of the sound mechanism and its sound mechanism with and its sound resulting in a “natural pattern” is a design process as well) since the message consists of activation of the sound instrument producing a simple unvarying sound (including buoy bells, gongs and whistles; railway crossing bells, cab signal bells). However, some fog signals have patterns analogous to those of the energy emanations of lighted markings, and therefore, a deliberate design process is at work in those forms. A fog signal with a specific characteristic could, for example exhibit one of these patterns: one blast every 20 seconds (3 second blast) or two blasts every 20 seconds (2s bl, 2a ai, 2s bl, 14s [bl=blast, si=silence]). The designing of sound messages creates an identification for a given fog signal (as it does for any accompanying lighted aid).

Electronic markings represent a more complex entity. They are not part of the visible portion of the electromagnetic spectrum in themselves yet they need to be translated into what can be seen and/or heard. The designed messages can take many forms: a group of pulses in Morse code that can be translated into an alphanumeric code, an unvarying pulse that denotes a course or channel mid-point (as in the case of airport electronic devices), or energy in pulse forms that denotes location, or provides data from which locations can be ascertained (for example, long-range oceanic navigation forms); some airport markings also include sound messages as well.

This segment of Chapter 5 has traveled in a perhaps curious direction: to speak of the formulation of messages as design may not be a commonplace component of design. Yet design is very much involved: units of energy are arranged into message patterns which are as deliberately crafted as those of architectural forms, objects or clothing. But instead of tangible, long-lasting designs, the design of message consists of short-lived entities endlessly repeated. T-M forms are designed objects. This is as true of messages as well as the physical apparatus.

"... we must realize that design does not stop at the form of a chair or the shape of a column. Everything man [/woman] *makes* is design, whether with material as hard as granite or as elusive as thought. Design controls our whole life--our whole happiness depends on it."

Paul Grillo, *Form, Function & Design*, 1975

APPENDIX

TERMINOLOGY FOUNDATIONS OF TRANSPORTATION-MARKINGS

i) Core Terms and Meanings

1) Introduction

a) Prefatory Statement

Aproximately 10-12 years ago I prepared a list of core terms employed in T-M studies. The terms were mark/ marker/marking (“3M). The list was compiled by counting the occurence of those terms in the monographs. The terms were divided up by transportation-mode groups.

The underlying reason for preparing the list was not included with the terms. The unstated reason was grounded in a concern about the frequent misuse of the term Transportation-Markings. The compilation of multiple-uses of the “3-Ms” helped to buttress the contention that T-M is a viable and plausible overarching term for the integrative studies known as T-M.

In 2005 several pages were added to the original list. These additional pages included definitions for the “3-Ms” as well as variant terms and sources. The 2005 addition was augmented by the LC Subject Heading entry for T-M, terms that “compete” with T-M, and “pre-history” terms.

In the following year it seemed evident that the original list and the additions needed a link that would draw together the expanding collection of foundational terms, their meanings, and underlying terminology within/without T-M. But that material did not add up to an adequate link. Perhaps the information (for Part A, 2008) may have provided an explanation that can link the diverse information of this Appendix. The second segment of this Introduction (Part Iv 2006) examines the problem of T-M and the misuse of that term as well as a review of possible perspectives on transportation, the literature and safety aids.

b) Uses of T-M and Perspectives on Transportation

The term Transportation-Markings can be said to be a problem in itself. That problem was not originally evident though perhaps it should have been. In 1994 the term was seemingly confirmed in its original meaning by the Transportation Library at UC-Berkeley. In that year one of their librarians referred to me as the only one working in the field. In fact, it was said that I had the field to myself. However, at a later date I discovered that the term was employed as little more than a synonym for pavement surface markings in Melvyl, the UC online catalogue. This was seemingly contrary to the view expressed by the Transportation Library. By then the alternate, and incorect, usage was probably firmly entrenched. The Library Congress added Transportation Markings as a Subject Heading in 1981and in the correct form. Yet the incorrect meaning has not lost its ability to misconstrue the correct usage. It can also be noted that pavement markings are within the LC Subject Heading.

It is possible that an alternate term, Transportation

Marks (Transport Marks UK is a second alternate), might have proved more acceptable. The term mark has had a long use in seamarks and marks in various forms and languages are the core term for safety devices. However, markings took hold and an alternate could not easily become entrenched.

Perhaps a partial resolution of the terminology conundrum involves the acceptance of multiple perspectives not only of terms but also of integrative transportation safety aids.

For example, transportation specialists, engineers and related personnel have an established way of looking at things. That perspective leads to viewing Transportation Markings in a certain way. I have contested and worked against their use of Transportation Markings though to little avail. But in so doing I have played -- in a manner of speaking -- on their turf and used their rules even while contesting them.

A second perspective may consist in sidesteping the engineering, transportation and transportation literature frame of reference. It instead adopts a different frame of reference consisting of a lexical and historical viewpoint. Such a perspective examines how terms such as mark and marking are utilized in dictionaries over many years and even centuries; it would also examine how safety aids under those terms have functioned in transportation settings. The core terms in that viewpoint consists of marks and related terms in a variety of languages. This procedure may also uncover primitive usages that were part of an early transportation "community" which may initially bear few links with modern transportation practice and theory.

The material added in 2005 drew primarily on several dictionaries and on the usage of very old aids in Iceland and Norway*. Further study may uncover similar usages in other nations as well. The intended and original meaning of Transportation-Markings is workable when lexical and historical sources are employed. This may not “wear well” with modern transportation science. Nonetheless, this alternate genealogy for Transportation-Markings provides a plausible foundation for it. One can compete with those organizations and persons who insist on using Transportation-Markings in a different manner only by following a different perspective.

*The earlier edition included Scotland. I understood a reference to Waymarker to mean a road marking device. But re-examination of the term and source indicates it referred to a coin known as waymerk. The term Waymerk is not far removed from a form of safety aid of Waymark.

2) Sources Employing Mark, Marker, Marking

a) Mark/Marker/Marking

Mark:

“An object on shore or at sea, which, by its ascertained known position, serves to guide a traveller preceeding in a given direction especially a landmark, leading-markings, seamark.” OED 1933, Vol. VI, L-M, page 167.

“An object or a point that serves as a guide ... .” AHDEL 1992, page 1100.

“...something serving as an indication of position, as a landmark.” RHDEL 1970, page 1177.

Marker:

“... one that marks or serves as a marker as: ... c. A milestone.” AHDEL 1992, page 1101.

“... an object used to indicate a position, place, or route.” NOAD 2001.

Marking:

“... a mark, or pattern or marks, artificial or natural ... .” OED 1933, Vol. VI, L-M, page 174.

“ ... a mark, or a number or patterns of marks ... .” RHDEL 1970, 1178.

“ ... arrangement, pattern, or disposition of marks ... .” WTNID 1971, Vol II, page 1383.

Sources

AHDEL: *American Heritage Dictionary of the English Language*. 1992.

NOAD: *New Oxford American Dictionary*. 2001.

OED: *Oxford English Dictionary*. 1933.
RHDEL: *Random House Dictionary of the English Language*. 1970.
WTIND: *Webster's Third New International Dictionary*. 1971.

Onions, C.T., ed. *The Oxford Dictionary of English Etymology*. 1966.
Partridge, Etric. *Origins: A Short Etymological Dictionary of Modern English*. 1967.

b) Variant Forms

Seamark. This is a general term for all forms of marine aids in *Our Seamarks* (E.P. Edwards, 1884). Lighthouses, Lightships, Beacons, Buoys, Fog Signals are included. Radio Aids are understandably absent. *Seamarks* (J. Nash) is a somewhat general term and a century newer (1985). Visual floating and fixed aids are prominent; fog signals and radios have only limited mention.

Sea-Mark. "A conspicuous object distinguishable at sea which serves to guide or warn sailors in navigation." OED, Vol. IX, S-Solda, pg 330.

(Navigation) Mark
(Visual) Aid (to navigation)
Seamark

IALA's *International Dictionary of Aids to Marine Navigation* (2-6-200), Ch 2, Visual Aids, lst ed., 1970 presents

Seamark in an assemblage of seven terms and variant terms with one definition: “An artificial or natural object of easily recognizable shape or colour, or both, situated in such a position that it may be identified on a chart or related to a known navigational instruction ... .”

Waymark (and Way-mark). An object, whether natural feature or artificial structure, which serves as a guide to the traveller.” OED 1973, Vol. XII, V-Z, pg 211.

Waymerk. This “term” was included in the previous edition but it may prove to be a red herring. It was my original understanding that it was employed in Scotland as a trail waymarking device. However, it is now apparent that it refers to coin or tokens. The objects were placed along trails with the intent they could be found. There are markers on the trails that have a waymarking function. (Southern Upland Way).

Sjømerker/Sjómerki. These terms originate in Norway and Iceland respectively. (Iceland 1960, Norway, ca. 1979). Merki and Merker constitute a common core term for one ancient transportation mode. Sweden employs an alternate spelling for sea marks: Sjömärke. (Sweden 1985).

c) LCSH

Library of Congress Subject Heading:
Transportation Markings
Use For: Markings, Transportation
Broader Topics: Signs and Symbols
Narrower Topics: Daymarks
Landing Aids (Aeronautics)
Road Markings
Traffic Signs & Symbols
Buoys

Note: LOC includes some marine, aero, and road forms though no rail forms. LOC was seemingly influenced by the first book of Transportation Markings (UPA 1981) yet their usage only partially encompasses what is found in that work.

3) Other Terms

a) Beacon, Signal, Sign: Other Primary Terms

The terms Mark, Marker, Marking undergird T-M to a substantial degree. But Marking in whatever form cannot fully encompass the matter of safety and control in transportation. There are other basic terms that share the overarching terminology need. Many of these other core terms are more specialized than the Marking group. Primary terms include Signs, Signals, and Beacon.

Signs are employed in massive numbers for road safety. Signs are often unlighted for road through frequently lighted in aero use. Aero uses include many signs though fewer in roads. Railways display a much more limited range of signs as well as numbers; marine uses much less so. Signs refer to a type of safety aid that often includes alphanumeric symbols displayed in a vertical dimension.

Beacons are often marine in nature. The term frequently refers to unlighted aids (e.g. Daybeacons). However, it can be employed with lighted aids. The beacon mode refers to constant, unchanging messages. The term beacon is also employed for traffic beacons at road intersections that display unchanging messages. This contrasts with road signal (and rail signals) with their changing messages. Limited Radio Aids are termed Beacons.

Signals are employed primarily with road and rail operations where changing messages are required. Signals are frequently employed continuously. Fog Signals represent a anomaly in that their messages are in a beacon mode.

Beacon, Signal, and Signs terms are used extensively, and most often employed in specific modes. Marking terms appear in all modes and manifest sound, visual, or electronic forms. There are also other terms that find some usage in transportation. They include aids, lights (as a noun), and devices.

b) Terms that Compete with Transportation-Markings

The term Operational Control (Hays 1977) may have possibilities though it needs to be placed within a context of transportation to be effective in T-M use. The Internet can generate numerous entries on operational control which produce diverse forms but T-M usage requires context.

Operational Control includes control in many forms including signals, navigational aids.

Traffic Control Devices. Some sources try to employ this as an overarching term for all transportation safety aids. However, that term has referred to road and street signals, signs, markings since at least 1930 (Hawkins 7-92, 26). The long-enduring meaning prevents general usage. Search engines also include the term with its traditional meaning. Wright and Ashford 1998 are an example of the attempt to use TCD as a general term. They add highway to TCD in order to distinguish road usage from general usage.

Traffic Control has a more significant and legitimate use. It can encompass many forms of transportation and matters relating to control (AccessScience 2006; F.D. Hobbs 2005). It refers more precisely to road and rail situations than to marine; some aspects of aero operations can also be placed within traffic control. However, adding Device to Traffic Control is a more problematical issue as noted above. Traffic Control & Safety constitutes a variant form employed by F.D. Hobbs and Paul Jovanis in EB. Sunwize.com (2005) offers a second variant with Traffic Safety & Control. Both variants possibly improve on the core term.

Traffic-Control Systems is a more explicit form and can include safety aids more adequately than the above terms (Constantino 1992; AccessScience 2003).

Transportation Control Devices occurs a few time on the internet. The term appears to be largely a synonym for Traffic Control Devices. It might have served as the general term if adopted in the 1920s or 1930s as an overarching term for all safety aids thereby contravening Traffic Control Devices. The International Technology Education Association employs that term in an educational document entitled Resources in Technology '85. Their use of the term seems to increase the plausibility of that alternate term.

The term Safety Aids may appear to be a possible overarching term. While the term has many uses (Google lists more than 142 million entries [Bing has slightly over 18 million]) few of these have reference to transportation safety and control situations. Transportation Safety Aids may be more plausible yet it is too imprecise to be an adequate term (Google has 3.25 millions while Bing has 4.5 million entries).

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Bing, and Google search engines for Safety Aids, Transportation Safety Aids and Transportation Control Devices.

c) Overarching Terms Employed 1969-1975

I have never known exactly when or where the term Transportation-Markings first was employed in my studies. For a time I used that execrable term “Beaconology.” Then at some point T-M appeared fully-hatched or so it seemed. I had looked in old manuscript materials for traces of the term but initially without success. A second search proved more successful. That began poorly but then unexpectedly I found a near term in the old Anthological Survey of Beaconology (ca. 1972). In a discussion of possible replacement terms there is this term: Transportation Waymark. In the revised edition of that manuscript a hyphen is added. It was surprizing to find a term so close to the later version at an early stage.

Quite possibly a process of gestation over terminology generated that near-term. And the current Transportation-Markings later appeared though without noting its arrival. The anthological manuscript most likely is from 1972. It is possible that some materials are from 1971 or 1973. The Main Classification Chart is probably from 1974. And between Feb-March and October of 1975 I assembled a short manuscript to go with the classification. That first actual manuscript was entitled Transportation Markings. The term is therefore older than expected. There is an inked comment in the anthological work that seems to suggest adding signal to beacon. And in some type fragments the term signal-beacon seems to have replaced beaconology. But that was a transitional move only.

ii) The Use of Mark/Marker/Marking in T-M

a) *MARINE AIDS TO NAVIGATION*

Marks

Bifurcation Marks
Buoyage Marks
Cable Marks
Cable/Pipeline Marks
Can Marks
Cardinal Marks
    North, South, West, East Cardinal Marks
Channel Marks
Clearing Marks
Coastal Marks
Conical Marks
Crossing Marks
Crossing Transit Marks
Day Marks/Day-Marks/Daymarks
Edgemarks
Fixed Marks
Floating Marks

Guiding Marks
In-Band Ramark
Isolated Danger Marks
Junction Marks
Landfall Marks
Landmarks
Lateral Marks
Leading Marks/Leading-Marks
Lighted Marks
Main Bank Marks
Marks
Marks & Signs for the Sea
Marks Indicating Bank to Hug
Marks Indicating Prohibited Entrance for Danger
Marks of Recognition
Mid-Channel Marks
Middle Ground Marks/Middle-Ground Marks
Military Exercise Zone Marks
Natural Marks
Navigation Marks
Ocean Data Acquisition Marks
Outfall & Spoil-Ground Marks
Port Hand Marks/Porthand Marks/Port-hand Marks
Post Marks
Post-Marks
Quarantine-Ground Marks
Quarantine Marks
Ramarks
Range Marks
Rangemarks
Range Target Marks
Recreation Zone Marks

Safe Water Marks
Sea Mark/Sea-Mark/Seamark
Shore Marks
Spare Marks
Special Marks
Spherical Marks
Spoil-Ground Marks/Spoil Ground Marks
Starboard Hand Marks/Starboard-Hand Marks
Topmark/Top-Marks
Topmark Buoys
Traffic Separation Marks
Transit Marks
Transition Marks
Undefined Marks
Wreck Marks

Marker

Back Marker
Buoy Range Markers
Cardinal Marker
Channel Marker
Fairway Marker
Floating Marker
Front Marker
Leading Marker
Marker
Marker Rocks
Marker Buoy
Marker Radio Beacon
Radar Marker

Radar Marker Buoy
Radio-Marker Beacon
Range Target Marker
Shoreside Marker
Starboard Hand-Marker
Warning Regulatory Marker
Winter Marker

Markings

Cardinal Buoyage Markings
Cardinal System of Markings
Channel Marking
Danger Marking
Daymarkings
Fixed Markings
Fixed Marine Markings
Floating Markings
Harbor Turning Circle Marking
Isolated Danger Markings
Lateral Markings
Marking Systems
Marking of Areas-Military
Ocean Data Acquisition Markings
Safewater Markings
Side-Marking System
Spoil-Ground Marking
Wreck Markings
Wreck-Marking Buoys

Notes:

The terms of 2008 should be fully reflected in CCI 2007. Yet more than a few terms were not included. That issue is compounded by terms that are not of an official status and otherwise non-standardized. The result is a survey of diverse terms that have significance but are not of an uniform quality. The following brief notes indicate terms in 2007 and other terms omitted in 2012.

Marks:
Isolated Danger Marks, 2006; 2012 but not in index.
Leading Marks, 2006; Ii, 2007 (Leading-Marks: in 2008)
Marks of Recognition, 2008; source unknown.
Middle Ground Marks/Middle-Ground Marks, 2006; 2012 but not in 2012.
New Danger Mark is a possible misnomer; listed in 2008.
Post Mark labelled unknown in 2008; with hyphen in 2012.
Quarantine-Grounds, in 2006; in 2012 text but not in index.
Quarantine Marks, 2008; source unknown.
Range Marks, in 2006; in 2012 text but not in index.
Spoil-Grounds Marks lacks hyphen in Iv. Part 2007 includes Spoil Grounds Marks. Both are included here.
Topmark/Top-Marks not in 2006 or 2012. Listed in C/D 2010, and Ii 2007.

Markers:
Back Marker, 2008 only.
Fairway Marker, 2008 only.
Floating Marker, 2008 only.
Front Marker, 2008 only.
Leading Marker, 2008 only.
Marker Radiobeacon in 2008 but Radio Beacon in 2012
Radio-Marker Beacon in 2008: misconstrued term for Radar

Marker (Ramark) or Radar Marker Beacon.
Radar Marker, in 2006 and 2012 but not in 2008.

Markings:
Cardinal Buoyage Markings, Ii 2007 only.
Cardinal System of Markings, Ii 2007 only.
Channel Markings, 2008 only.
Danger Markings, 2008 only.
Daymarkings, 2008; also C/D 2010.
Floating Markings, Ii, 2007.
Harbor Training Circle Markings listed in 2008 but also Harbor Turning Circle Markings; the latter is correct and in Ii, 2007.
Lateral Markings, 2008 should be Lateral Marks.
Marking of Areas-Military omits Buoy in Iv but added in this study; neither included in 2012.
Marking Systems, Ii, 2007.
Ocean Data Acquisition Markings, 2008, should be Marks.
Safewater Markings, 2008, should be Marks.
Side-Markings Systems, Ii, 2007.
Spoil-Ground Markings, 2008 should be Spoil Grounds Marks.
Wreck Markings, 2008.

b) Aeronautical Navigation Aids

Marks

Mark
Air Mark

Air-Mark
Ground Marks* [* = Part Iv 2012 includes term]
Uniform System of Ground Marks

Markers

Above Ground Marker
Aiming Marker for Turbojet Operations
Aiming Point Marker*
Air Marker/Air-Marker/Airmarker
Air (Roof) Marker*
Air Taxiway Marker
Aircraft Arresting Marker
Approach Day Marker
Back Course Marker/Back Course Marker Beacon
Barrier Engagement Marker
Barrier-Engagement Marker
Bidirectional Reflective Marker
Boundary Day Marker [Day & Radio]
Boundary Marker
Centerline Marker
Circle Marker
Cone Marker
Conical-Shaped Marker
Contact Lights of the Marker Type
Corner Marker
Cylindrical Marker
Cylindrical Raised Marker
Day Marker
Day Marker for Snow-Covered Runway
Disc Warning Marker

Distance Marker
Distance To Go Marker/Distance-To-Go Marker
Edge Marker/Edgemarker
Edge Marker for Snow-Covered Runways
Elevated-Edge Marker*
Elevated Marker
Elevated Taxiway Edge Marker
En-Route Marker Beacons
En-Route VHF Marker Beacons
Fan Markers
Fan Marker Beacons
Fan-Type Markers
FATO Edge Markers
1500-Ft Markers
Fixed Distance Markers
Flag Markers
Flush-Type Markers
Geographical Distance Markers*
Half Way Markers
Helicopter Air Markers*
Helicopter Approach Markers
Helicopter Markers
Heliport FATO Markers
Hold Line Markers
Hook Cable Markers
Home-made Markers*
Identification Markers
Illuminated Day and Night Markers
ILS Inner Markers
ILS Inner Marker Beacon*
ILS Markers*
ILS Marker Beacons

ILS Middle Marker Beacons
In Ground Corner Markers
In-Ground Edge Markers
Inner Marker Beacons
Landscape Markers
Limed Markers
Lorenz Glide & Marker Beacons
Low-Frequency Markers
Low-Elevation Markers*/Low Elevation Markers*
Low-Powered Fan Markers
Low-Powered Version of the Fan Markers
Low-Power Radio Marker Beacons
"M" Markers
"Manmade" Markers
Markers
Markers (within Obstruction Markings)
Markers
    Flags
    Spherical
Marker Beacon (Mkr)/Marker Beacon*
Marker Beacons, 75 MHz
Marker Beacon Stations
Marker Beacons (Inner, Middle, Outer)
Marker Circle
Markers for Snow-Covered Runways
Markers Under Name of Marker*
Markers, Retroreflective
Middle Marker Beacons
Natural Above Ground Markers
Navigational Boundaries & Obstruction Markers*
Non-Directional Markers
Nondirectional Radio Marker Stations

Non-Snowplowable Markers
Obstruction Markers
Outer Markers
Outer Marker Beacons
Painted Highway Markers
Plane Markers
Pole-Mounted Markers
Power Line Obstruction Markers
Radio Markers
Radio Marker Beacons
Radio-Marker Beacons
Raised Edge Markers
RBI Markers
RBI Retroreflective Markers
Reflecting Distance Markers
Reflecting Markers
Reflecting Markers
Reflective Distance Markers*
Reflective Markers*
Retroreflective Airport Markers
Retroreflective Identification Markers
Retroreflective Markers
Retroreflective Pavement Markers
Retroreflective Runway & Identification Markers
Roof Town Markers
Runway & Taxiway Retroreflective Markers
Runway Distance Markers
Runway Marker
Runway Touchdown Zone Marker
Safe Heading Marker Boards
Segmented Circle Marker System
Segmented Marker

Semiflush Marker
Semiflush Marker for Centerline Marking
Semiflush Retroreflective Markers
75-mc Marker System*
75 MHz ILS Marker
75-mc Fan Marker
75 mc Marker System
Signs Under the Guise of Markers*
Snowplowable Marker
Solid-State Marker
Sphere Marker
Sphere/-ical Markers*
Spherical Markers
Standard Air Markers
Standard Boundary Markers
Standard Markers
Station Localizer Markers
Stopway Day Markers
Stopway Edge Markers
Stopway Markers
Supplemental Reflective Markers
Supplementary Markers
System of Approach Day Markers
Taxiway Centerline Markers/Taxiway Centre Line Markers
Taxiway Edge Markers
Taxiway Ending Markers
Taxiway Holding Post Marker
Taxiway Route Edge Marker
Threshold Markers
Type I-VI Markers
  Bidirectional Reflective Markers
  Reflective Markers

Ultra High Frequency Radio FM Markers
Ultra-Short Wave Markers
Unidirectional Reflective Markers*
Unidirectional L-853 Type IV Markers
Unpaved Runway Edge Markers
Unpaved Taxiway Edge Markers
Unserviceability Markers (Cones, Flags, Markers)
Unserviceability Marker Boards
Vertical Marker Beacons
Vertical Runway Distance Markers
VHF Marker Beacons
V-H-F Markers
VOR Check-Point Markers
Z Markers/Z-Markers
Z Marker Beacons

Markings

Aim Point Markings
Aiming Point Markings
Air Markings
Airfield Markings
Airmarkings
Airport Markings
All-Weather Runway Markings
Alphanumeric Markings*
  LI, MI, HI
Approach Day Marking Systems
Apron & Holding Pad Shoulder Markings
Apron Markings
Basic Markings

Blast Pad & Over-run or Stopway Markings
Boundary Markings
Centerline Markings/Centre-Line Markings/Centre Line
Markings
Check-Point Markings
Checkpoint Markings*
Chevron Markings
Closed Markings
Closed or Temporarily Closed Runways & Taxiway
Markings
Closed Runway & Taxiway Markings
Conflicting of Runway Markings
Continuous Markings
Critical Area Hold Line Markings
Dashed FATO Markings
Dashed Markings
Day Markings
Day Marking of Obstructions
Day Marking of Snow-Covered Runways
Day Marking-Taxying Aids
Daytime Markings
Designation Markings
Edge Holding Position Markings*
Edge Markings
Equipment/Object Marking
FATO Markings
Final Approach & Take-Off Area Markings
Final Approach & Take-Off Designation Markings
Fixed Distance Markings
Geographic Position Markings
Graphic Markings*
Ground Receiver Checkpoint Markings

Guidance & Position Markings
Guidance or Position Markings
Hanger Roof Markings
Helideck Obstacle-Free Sector Markings
Helipad & Helideck Markings
Heliport Guidance, Position & Other Markings
Heliport “H” Markings
Heliport Identification Markings
Heliport Markings
Heliport Name Markings
Holding Position Markings [13 permutations of this term]
Hospital Heliport Markings
Hospital Markings
ILS Holding Position Markings
Identification Markings
  Hospital Heliport Markings
  Standard Heliport Markings
In-Ground FATO Corner/Edge Markings
In-Ground Markings
Instrument Runway Markings
Intermediate Holding Position Markings
Landing Zone Markings
Longitudinal Markings
Longitudinal Runway Markings
Low-Power Version of the Fan Marker*
Low-Powered Fan Markings
Markings
Marking Aids
Markings Displaced Thresholds, Blast Pads & Stopways
Markings for Arresting Gear
Markings for Blast Pad or Stopway or Taxiway Preceding a
  Displaced Threshold

Markings for Large Aircraft Parking Positions
Markings for Paved Runways & Taxiways
Markings for Surface
Markings for Unpaved Markings
Markings for Closed Heliport
Marking of Closed or Hazardous Areas on Airports
Marking of Displaced Thresholds/Displaced Threshold Markings
Marking of Hazardous Areas
Marking of Paved Areas
Marking of Snow-Covered Runways
Marking of Temporarily Relocated Thresholds
Marking of Unserviceable Portions of the Movement Area
Maximum Allowance Mass Markings
Non-Movement Area Boundary Markings
Non-Precision Instrument Runway Markings/Nonprecision Instrument Runway Markings
Nonprecision Runway & Visual Runway Markings
Obstacle Markings
Obstruction Markings
Off-Airport Markings
On-Airport Markings
Other Markings*
Other Surface Markings*
Paint Markings
Painted Cones for Day Markings
Painted H Markings
Painted Hold Position Markings
Painted Markings
Park Position Markings
Pavement Markings
Paved Taxiway Day Markings

Pendent Cable Markings
Precision Instrument Runway Markings
Roof Markings
Relocated Threshold Markings
Runway - & Taxiway - Surface Markings
Runway & Taxiway Markings
Runway Centerline Markings/Runway Centre Line Markings
Runway Central Circle Markings
Runway Day Markings
Runway Designation Markings
Runway Edge Markings
Runway End Markings
Runway End-Zone Markings
Runway-Holding Position Markings
Runway Holding Position Markings on Runways
Runway Holding Position Markings on Taxiways
Runway Intersection Markings
Runway Markings
Runway Mid-Point Markings
Runway Shoulder Markings
Runway Side Stripe Markings
Runway Surface Markings
Runway Threshold Markings
Seaplane Base Markings
Segmented Circle Marking Systems
Shoulder Markings*
Side Stripes Markings
Signs & Markings*
Standard Heliport Marking Symbols
Standard Markings
Striated Markings
Surface Markings

Surface Markings Under Heading of Markers*
Taxi-Holding Position Markings
Taxi Route & Taxiway Markings
Taxi Route Edge Markings
Taxi Route Markings
Taxiway Centerline Markings/Taxiway Centre Line Markings
Taxiway Continuous Markings
Taxiway Dashed Markings
Taxiway Day Markings
Taxiway Edge Markings
Taxiway Holding Line Markings
Taxiway Holding Position Markings
Taxiway Identification Markings
Taxiway Intersection Holdline Markings
Taxiway Intersection Markings
Taxiway Markings
Taxiway/Runway Intersection Markings
Taxiway Route Markings
Taxiway Shoulder Markings
Taxiway Side Stripe Markings
Taxiway Surface Markings*
TDZ Markings*
Temporary Markings
Threshold Markings
Touchdown & Landing Area Markings
Touchdown Markings
Touchdown Pad Bounday Markings
Touchdown Zone Markings/Touchdown-Zone Markings
Transverse Marking
Undershoot & Overrun Area Markings
Unidirectional Ref
Unpaved Runway Markings

Unpaved Taxiway Markings
Unserviceability Markings
Vehicle Roadway Markings
Vertiport Markings*
Visual & Nonprecision Markings
Visual Runway Markings
VOR Aerodrome Check-Point Markings
VOR Checkpoint Markings
VOR Checkpoint Receiver Markings
VOR Receiver Checkpoint Markings
Weight Limit Markings
Winching Area Markings
Wire Markings
Zipper Markings

Notes

Aero Transportation-Marking forms represents a complex situation. Terms in the first edition of “3M” frequently lacked sources. This second edition includes not only that earlier problem but also many other issues. Categories have been constructed that list and arrange the diverse problems. Further work may resolve at least some of the irregular situations of terms.

The categories and descriptions include:

Problem Terms. These terms are listed in Part “A” 2008 but without a source.

Partial Problem Terms. Some terms are partly identified though a portion of the term is at variance with other components of the term.

Complex Terms. Some terms are easily misconstrued because similar words may have inadvertently employed a similar term. Examples include a term beginning with ILS and followed by descriptive terms like inner, middle, or outer which may have been added or substracted some of the qualifying terms. Marker and marking are also terms that may or may not be included; beacon is also a common added or omitted term. Reflector, reflective, reflecting are additional examples.

Existing Terms with New Source. Some terms are lacking a source in the previous editions. However, other sources have been located and attached to those terms.

New Terms. Perusal of monographs may have uncovered heretofore unknown, or at least, not listed terms.

Marks:

New Term:
Ground Marks, Part "J", 2002.

Markers:

Complex Terms:
ILS Inner Markers
ILS Marker Beacons
Marker Beacon Station
Marker Beacons (Inner, Middle, Outer)
Middle Marker Beacons

Middle Marker Beacons
Non-Directional Markers
Reflecting Distance Markers
Reflecting Markers
Unidirectional Reflective Marker. Part “H” 2010.

Existing Terms with New Source:
En-Route Edge Marker. Part “H” 2010.
Heliport FATO Markers. Part “G” 1994.
Obstruction Markers. Part “B” 1991 (Index only).
Outer Marker Beacons. Part “G” 1994.
Reflecting Markers. Part “Iv” 2009.
Runway & Taxiway Retroreflective Markers. Part “H” 2010.
Runway Distance Marker. Part “Iv” 2009.
Semiflush Marker. Part “Iv” 2009.

New Terms:
Aiming Point Marker. Part “H” 2010.
Air (Roof) Marker. Part “H” 2010.
Barrier-Engagement Marker. Part “H” 2010. A non-hyphenated form is already in place.
Elevated-Edge Markers. Part “H” 2010.
Geographical Distance Marker. Part “H” 2010.
Heliport Air Marker. Part “H” 2010.
Home-Made Markers. Part “J” 2002.
ILS Inner Marker Beacon. Part “Iv” 2009.
ILS Markers. Part “Iv” 2009.
Low-Elevation Markers. Part “H” 2010.
Low Elevation Markers. Part “H” 2010.
Marker Beacon. Part “H” 2010.
Markings Under Name of Markers. Part “H” 2010.
Navigational Boundary & Obstruction Markers. Part “Iv”

2001.
Reflective Distance Markers. Part "Iiv" 2009.
Reflective Markers. Part "Iv" 2009.
75-mc Fan Marker. Part "Iv" 2012.
75-mc Marker System. Part "Iv" 2012.
Signs Under the Guise of Markers. Part "H" 2010.

Problem Terms:
Boundary Day Marker [Day & Radio]
Conical-Shaped Marker
Disc Warning Marker
Helicopter Markers
Hook Cable Markers (previous entry in Part "A" 2008 notes).
Lorenz Glide & Marker Beacons
Low-Frequency Markers
Markers (previous entry in Part "A" 2008 notes).
Ultra-High-Frequency Radio Fan Markers.
Vertical Runway Distance Marker

Partial Problem Terms:
Centerline and Markers. It is also listed as a Marking. One sources lists both forms but in separate publications.
Low-Powered Fan Markers
Low-Power Versions of the Fan Marker
Lowered or Low-Powered or Power Radio Marker Beacons
Semiflush Marker for Centerline Markings
75 mc Fan Marker. (Part "Iiv" 2009 at variance with "Iv.")
75 MC Fan Marker System. (see above)
Station Location Markers
Surface Markings Under Heading of Marker. Part "H" 2010; DB-Aero includes Surface Markings & Markers.

Taxiway Holding Post Markers in DB-Aero 2009.

New Terms:
Alphanumeric Markings. Part “H” 2010.
Checkpoint Markings. Part “H” 2010. (Check-Point Markings is currently in Part “A” 2008).
Edge Holding Position Markings. Part “H” 2010.
Graphic Markings. Part “H” 2010.
Low-Power Version of the Fan Marker. Part “Iiv” 2009.
Other Markings. Part “H” 2010.
Other Surface. Part “H” 2010.
Shoulder Markings. Part “H” 2010.
Side Stripes Markings. Part “J” 2002.
Signs & Markings. Part “H” 2010.
Taxiway/Runway Intersection Markings. Part “Iiv” 2009.
Taxiway Surface Markings. Part “H” 2010.
TDZ Markings. Part “H” 2010.
Vertiport Markings. Part “H” 2010.

Existing Terms with New Source:
Dashed Markings. “Iiv” 2009.
Designation Markings. Part “H” 2010.
Edge Markings. Part “H” 2010
Guidance & Position Markings. “Iiv” 2009.
Guidance or Position Markings. “Iiv” 2009.
Helipad & Helideck Markings. “Iiv” 2009.
Heliport Guidance, Position & Other Markings. Part “Iv”. 2009.
Low-Powered Fan Parkings. Part “Iiv” 2009.
Marking of Temporarily Relocated Thresholds. Part “Iv”

2009.
Marking of Hazardous Areas. Part “Iiv” 2009.
Marking of Unserviceable Portions of the Movement Area.
Part “Iv”. 2009.
Roof Markings. Part “J” 2002.
Runway Holding Position Markings. Part “Iiv” 2009.
Runway Holding Position Markings on Runways. Part “Iiv”.
2009.
VOR Checkpoint Markings. Part “Iv” 2009.
VOR Checkpoint Receiver Markings. Part “Iiv” 2009.
VOR Checkpoint Checkpoint Markings. Part “Iv” 2009.

Partial Problem Terms:
Conflicting Runway Markings.
Holding Position Markings. 9 entries in Part “A” 2008 and
13 in Part “Iv” 2009.
Markings for Unpaved Runways. Part “Iv” 2009.
Painted Cones for Day Markings. Part “Iv” 2009.

Problem Terms:
Edge Markings (Note in Part A 2008).
Pendent Cable Markings
Runway Intesection Markings
Sidestripes Markings (Source: Part J 2002).
Taxiway Route Edge Markers instead of Markings. Part “Iv”
2009 and listed in Markings, Markers.
Taxiway/Runway Intersections Markings (Source found in:
Part Iiv 2009).
Visual Runway Markings
Zipper Markings

c) Railroad Signals & Other Devices

Marks

Clearance Marks
Coasting Marks -- AC & DC
Electric Train Section Marks
Landmarks
Marks
Power Drive Marks
Route Identification Marks
Signal Alarms Marks
Signal Aspect Confirmation Position Marks
Slow Speed Release Marks
Station Approach Marks
Sudden Release Shunting Sign Marks
Tablet Carrying Marks
Train Stop Position Marks

Markers

Alinement Markers
Auxiliary Markers
"C" Markers
Car Stop Markers
Countdown Marker Boards
Diamond Shaped Markers
Distance Markers
Elevation Markers
End of Section Marker Boards
Fixed Markers
High Speed Marker Boards

Lineside Markers
Markers
Marker Boards
Marker (Boards)
Marker Lamps
Marker Lights
Marker Plates
Marker Posts
Monument Markers
Once Stop Sign Markers
Reflective Marker Boards
Route Electric Source Sign Markers
"S" Markers
Section Entrance Markers
Shunting Sign Markers
Shunting Signal Markers
Signal Marker Boards
Spring Switch Markers
Train Stop Sign Markers
Trolley Wire Electric Source Sign Markers
Wayside Markers
Whistle Sign Markers
Wing Markers

Notes:

Only two notes are required for this edition. Several other notes are found in the previous edition.

Marks is the heading of one division but not added to the terms in the previous edition. It is now included.
Marker Light is the only new addition. It is recorded in Part

Iiii 2009.

d) Traffic Control Devices

Marks

Landmark
Luminous Mark
Mark
Mark Stone
Pavement Mark
Retro-Reflective Mark

Markers

Advance Turn Arrow Markers
Amber Markers/Green Markers/Red Markers
Alternate Markers
Alternate Auxiliary Markers
Auxiliary Markers
Bicycle Route Markers
Bi-Directional Edgeline Markers
Bi-Directional Red & White Retro-Reflective Markers
Bi-Directional Retro-Reflective Markers
Business Markers
By-Pass Marker/Bypass Markers
Cardinal Direction Markers
Cardinal Route Markers
Ceramic Markers
Channelization Markers

Clearance Markers
Combination Junction Markers
Confirming Route Markers
County Route Markers
Detour Auxiliary Marker Signs
Detour Markers
Directional Arrow Markers
Edgeline Raised Markers
Electrically Powered Emissive Markers
End of Road Markers/End-of-Road Markers
Evacuation Route Markers
Expendable Markers
Forest Route Markers
Formed-in-Place Markers
Guide Markers
Hazard Markers
Interamerican Highway Route Markers
Interstate Route Markers
Junction Markers
Magnetic Markers
Markers
Markers Adjacent to the Roadway
Markers for Alternate Routes
Markers for Objects in the Roadway
Mile Marker
Monodirectional Marker
National Route Marker
Non-Reflective Marker
Non-Reflective Ceramic Pavement Marker
Non-Retro-Reflective Ceramic Marker
Non-Retro-Reflective Marker/Non-Retro Reflective Marker
Non-Retro Reflective Raised Pavement Marker

Object Marker
Object Markers on Shared-User Path
Off-Interstate Business Loop Marker
Off-Interstate Business Spur Marker
Other Markers
Pan American Road Route Marker
Pan American Route Marker
Pavement Marker
Post Mounted Marker
Protuding Marker
Provincial Route Marker
Radioactive Emissive Marker
Raised Reflective Marker
Raised Reflective Lane Marker
Raised Reflective Pavement Marker
Raised Retro-Reflective Marker
Reassurance Route Marker
Recessed Reflective Marker
Reflective Marker
Reflector Marker
Relief Marker
Retro-Reflective Marker
Road-Delineator Marker
Route Marker
Route Marker Sign
Route Marker Tab
Route Marker & Auxiliary Marker
Shoulder Delineation Marker
Snap-over Marker
Snowplowable Reflective Marker
State Route Marker
Stone Marker

Temporary Marker Tab
Tourist Route Marker
Trans-Canada Route Marker
Trunk Route Marker
Tubular Marker
Turn Marker
US Route Marker
Width Marker

Markings

Advanced Speed Hump Markings
Alphanumeric Markings
Approach Markings for Obstructions
Approach Markings for Obstructions in Roadway
Approach to Railroad Crossing Markings
Approaches to Railway Crossing Markings
Arrow Markings
Bicycle Detector Markings
Carriageway Markings
Cates Eye Centerline Markings
Center-Line Markings/Center Line Markings/Centerline Markings
Centerline & Left Edge Line Markings
Centerline & Left Edge Line Pavement Markings
Centerline Markings for Shared-Used Paths
Center Markings
Coloured Cement Concrete Markings
Crossing Markings
Curb Markings
Curb Markings for Parking Restrictions

Curb Markings for Roadway Delineations
Curve Markings
Crosswalk Markings
Cyclist Crossing Markings
Delineation Markings
Directional Markings
Dynamic Envelope Delineation Markings/Dynamic Envelope Markings/Dynamic Envelope Pavement Markings
Edge Markings/Edge-Markings
Edge of Carriageway Markings
Edge Line Markings
Edge Line Pavement Markings
Electrically Powered Emissive Markings
End-of-Roadway Markings
Exit & Entrance Interchange Ramp Markings
Graphic Markings
Hazard & Delineation Markings
Hazard & Obstruction Markings
Hazard Markings
Highway Markings
Highway-Rail Grade Crossing Pavement Markings
Horizontal Markings
Horizontal Pavement Markings
Hot-Applied Surface Markings
Intersection Markings
Intersection Pavement Markings
Junction & Corner Markings
Lane Lines Pavement Marking
Lane Lines & Right Edge Line Pavement Markings
Lane Markings
Lane Reduction Transition Markings
Lane Selection Arrow Markings

Limits of Travelled Roadway Pavement Markings
Longitudinal Markings
Longitudinal Pavement Markings
Markings
Markings Adjacent to the Roadway
Markings at Particular Locations
Marking Devices
Marking Extensions Through Intersections or Interchanges
Markings for Bicycle Lanes
Markings for Object in the Roadway
Markings for Other Circular Intersections
Markings for Particular Situations
Markings for Roundabout Intersections
Markings of Obstructions
Markings of Pavement Space Limits
Marking Systems
Multiple-Directions Markings
No-Passing Markings/No-Passing Pavement Markings
No-Passing Zone Markings/No-Passing-Zone Markings
Object Markings
Obstruction Markings/Obstruction Pavement Markings
On-the-Roadway Markings
Paint Markings
Parking Markings
Parking Space Markings
Paved-Shoulder Markings
Pavement & Curb Markings
Pavement Edge Line Markings
Pavement Edge Markings
Pavement Markings
Pavement Markings Extensions Through Intersections
Pavement Markings for Obstructions

Pavement Surface Markings
Pavement-width Transition Markings
Parking & Standing Restriction Markings
Physical Pavement Markings
Preferential Lane Word & Symbol Markings
Preferential Lane Longitudinal Markings for Motor Vehicles
Railroad Crossing Markings
Railroad Crossing Advance Markings
Railroad-Highway Grade Crossing Pavement Markings
Raised Horizontal Markings
Raised Markings
Raised Marking Systems
Reserved Lane Markings
Road Markings
Road Marking Systems
Road Markings for a Lane Reserved for Certain Categories
of Vehicles
Road Surface Markings
Roadway Markings
Speed Hump Markings
Speed Measurement Markings
Standing & Pavement Regulations Markings
Stop & Yield Markings
Surface Dressing Markings
Surface Markings
Temporary Lane Markings
Traffic Delineation Markings
Traffic Lane Markings
Traffic Markings
Traffic Paint Markings
Train Dynamic Envelope Pavement Markings
Transverse Markings

Turn Markings
Vertical Markings
White Lane Pavement Markings
Word & Arrow Markings
Word & Symbol Markings
Yellow Centerline Pavement Markings

Other Terms

Marked Surfaces

Notes:

Complex references are required for this category. Problems for this complexity are caused by a variety of pre-existing terms absent in CCI 2012; a variety of anomalies are also present including a plethora of errors.

Approach Markings for Obstructions is found in Iii, 2008.
Approach Markings for Obstructions in Roadway appears in Iv, 2006 and 2012. “A”, 2008 omits “way” in Roadway.
Bi-Directional Retro-Reflective Markers are listed in CCI 2006 but not 2012.
Cardinal Direction Marker is listed in DB TCD 2008, and CCI 2012 but not in “A” 2008.
Cardinal Route Marker is in 2008 but no sources has been located.
Combination Junction Marker. It is included in DB TCD 2008 and “A” 2008 but not in CCI. Newer terms are now often termed Signs rather than Markers.
Evacuation Route Marker. See previous note.

Junction Marker. This terms appears in “B” 1992 and “A” 2008. The previous notes may apply here as well.

Marking of Pavement Space Limits: Parking not Pavement.

Multiple-Directions Markings is listed in CCI 2006 index but omitted in text. Iii 2008 includes listing in index and text.

National Route Marker is listed in Part E index but no text entry. This is an Australian term.

Non-Reflective Ceramic Pavement Marker is listed in CCI 2006 but not 2012.

No-Passing Markings/No-Passing Pavement Markings: not included in CCI 2012. The former term is included in Part “E” 2004; the latter in Iii 2008. Part B omits hyphen in former term.

A variety of terms that begin with Parking and Pavement are listed in Iii 2008 but omitted in Iv

Other Marker is in “E” 2004.

Pan American Route Marker included only in Part A, 2008 but CCI 2006 and Iii 2008 include a variant form: Pan American Route Road Marker.

Parking & Standing Restriction Markings: source unknown.

Pavement Marker is in CCI 2006 but not 2012

Pavement Marking in Iv 2006 should have been Parking Marking.

Post Mounted Marker in CCI 2012 and Iii 2008; the latter also has a hyphenated version in index but not in text.

Preferential Lane Word & Symbol Markings: listed in Iii 2008.

Railroad Crossing Advance Markings listed in Iii 2008.

Reflector Markers is included in Part E, 2004 but seemingly no other

Road-Edge Delineation Markers is in Part E, 2008 but no other source. Correct version employs Delineator instead.

Route Marker & Auxiliary Marker in CCI 2006 but in no other sources. However, terms when separate are found in several sources.
Standard & Parking Regulations in CCI 2006 but not 2012
Standard & Pavement Regulations Markings: Parking not Pavement should be present.
Temporary Marker Tab in Iv 2006 and 2012 but inaccurate since compiler applied the Canadian term Tab to US usage. Seee general explanation in Iii 2008.
Tourist Route Marker in Part A, 2008 only.
Traffic Pavement Markings: Paint rather than Pavement.
Tubular Marker in CCI 2006, Part A, 2008 only.
Width Marker in Part A, 2008 and Part E, 2004 only.
Word and Symbol Markings: Iii 2008 includes the term.

iii) Statistical Summary of Use of Mark/Marker/Marking in Transportation-Markings Monograph Series

Mark:

Marine	74	
Aero	4	
Rail	13	
	97	13.20%

Marker:

Marine	21	
Aero	158	
Rail	35	
Road	95	
	309	42.04%

Marking:

Marine	19	
Aero	183	
Rail	-	
Road	126	
	328	44.63%

Other:

Marked Surface: TCD 1

Total: 735

Mode Summary:

Marine	114	13.51%
Aero	345	46.94%
Rail	48	6.53%
Road	228	31.02%

Major Form(s) by Mode:

Marine	Marks 64.91% of total
Aero	Markings 57.01%/Markers 41.74%
Rail	Markers 72.92%
Road	Markings 55.26%/Markers 41. 67%

Note: The Writing Journal does not indicate when the "3M" idea began. Some of the apparently older notes include the first editions of Part Ii and Part Iii though not Part Iiii and Part Iiv. That may indicate a date of 1998-2000. Changes and additions were made in May of 2005 but those were clearly not the first steps in the manuscript. "3M" has been grafted onto Part A.

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i Marine, 1st-2nd eds., 1997-2007

ii TCD, 1st-2nds eds., 1998-2008

iii Rail, 1st-2nd eds., 2000-2009

iv Aero, 1st-2nd eds., 2001-2009

v Composite Categories Classifications & Index, lst-2nd eds., 2006-2012

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