TRANSPORTATION-

MARKINGS

FOUNDATIONS

TRANSPORTATION-MARKINGS
A STUDY IN COMMUNICATION
MONOGRAPH SERIES

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International Railway Signals, 1991 (Part F, Vol II)

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Transportation-Markings Database:
Marine, lst ed, 1997 (Part Ii, Vol III, Additional Studies in T-M)
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Railway, lst ed, 2000 (Part Iiii, Vol III)
Aero, lst ed, 2001 (Part Iiv)
(2nd ed of *Database*, Projected)

Transportation-Markings: A Historical Survey, 1750-2000, 2002 (Part J, Vol IV, Final Studies in T-M)

A Truly Integrative Transportation-Markings [Alternate Title: *Transportation Markings as an Information System*] (Part K, Vol IV, Projected)

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Transportation-Markings General Table of Contents with Index, 4th ed, 2005 (lst ed, 2002; 2nd edition, 2003; 3rd ed, 2004)

TRANSPORTATION-MARKINGS FOUNDATIONS

Part A, 4th Edition

Volume I, First Studies

Brian Clearman

Mount Angel Abbey

2005

Dedication is that of Volume I (Parts A-D, lst edition, 1981):

To My Parents:
Dad (1909-1980) Mom (1910-1973)
My Step-Mother Jennie (1911-1977)
My Step-Mother Mary (1912-2001)

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PROLEGOMENA

Prolegomena: The Original Revisited

The original Humboldt County Prolegomena for Part A has been great 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 Practit-ioners. 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 material for a monograph on Railway Signals. The suggestion was worked on but never included in that monograph. However, the idea took hold and 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 and now for this fourth 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 had 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 additions. However, the publisher for that first volume (which was part of a series in Semiotics) went bankrupt and the work went unpublished. During that time a second monograph was written. And during the time both monographs were sitting unpublished, the first portion of 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 studies have been listed by the pre-binding year rather than by the year of the binding. This was the case with Part B, 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 lst ed. Preface. The opening chapter was a revision, enlargement, and reformulation of the first two chapters of the old Part A. The former third and fourth chapters became a single chapter though augmented by a discussion of light. The next chapter, acoustical signals, was a new chapter and reviewed concepts in acoustics as well as examining acoustical signals. Electronic signal processes was 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 alphanumeric 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 even with divergent content.

A third edition of Part A was published in 1999. That edition added a segment on holarchy 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 more limited work on the design chapter was undertaken. The new 4th edition of Part A includes a much more extensive chapter on design. A primer including terms and concepts relating to design is the latest area of change. Reworking of the Prolegomena and updating of several chapters is also included. The contents of this 4th edition cover 35 years: 1969 to 2004. Differences in time periods, perspectives, topics, research materials and handling of materials are reflected in this current study which results in a work displaying both coherence and a multi-faceted diversity.

A second edition of Part B, *A First Study in T-M: The US* was published in 1993 (though listed as 1992 since the pre-binding completion date had been employed). The second edition is a markedly different production from the lst ed with a reduction of some materials, a variety of additions, as well as revisions retained materials. A review of the variety of classifications, explanatory notes and reconfigurations of materials are 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, classifications, descriptions of buoy types, and message systems. Fixed aids to navigation include chapters on methodology, lights, daybeacons, electronic aids and fog signals. Classifications, descriptions of types and message systems are subsumed within the relevant chapters. The monographs also includes appendices.

Two parts were originally assigned to Marine A/Ns 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. But the two-part approach has become fixed after more than 20 years. 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. 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.

The first edition of *International Traffic Control Devices*, Part E was first 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 and systems have a more secondary role. The approach of the 2nd ed. more closely follows the modal approach of the other monographs with international T-M themes than did the lst. ed.

International Railway Signals, Part F (1992) begins with a survey of semiotics, physical properties and history. While most of the monographs have not explicitly included semiotics, a need to return to fundamentals shaped this study. The railway signalling study includes chapters on classifications, colors and their meanings. Other chapters examine the types of signals, signs, markings as well as messages in more specific terms. The monograph ends with a glossary of terms and two appendices.

International Aeronautical Navigations Aids, Part G (1994), begins with an initial chapter dealing with terminology, methodology, and early history of aero aids. A second chapter takes up several forms of classification. Several chapters examine fully-lighted, partially and unlighted aids, and electronic aids including physical equipment and messages. The study ends with an appendix.

General Classification of International Transportation-Markings, Part H, has had two editions. The first in 1995 (but listed as 1994 as previously noted because of former practice of dating by pre-binding process)and a second in 2003. Part H is a brief work that brings together the various classifications throughout the previous works. Two primary chapters take up classifications within the contexts of transportation modes and message energy forms. A third chapter surveys variant classifications as well as an US T-M classification. 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 instead were employed (e.g., i, ii). The 2nd edition reverts to sub-chapters and sections.

The *Transportation-Markings Database* was envisioned as a single study though completed in increments. The extensive work needed for the Database required the incremental approach that generated quasi-autonomous studies. For at least an interim period of time the Database will be in four segments: Marine A/Ns (1997), Traffic

Control Devices (1998), Railway Signals (2000), and Aero Nav Aids (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.

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.

The intended final study, *A Truly Integrative T-M [Alt: T-M as an Information System],* Part K, is projected as a fully integrated study. Core and holistic dimensions of T-M would be the concern rather than a focus on T-M forms as was the case in the mode studies. It is possible that a mode-related dimension can be entirely omitted.

b) T-M: A Discipline?

This book is about "Transportation-Markings" (hereafter 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, obstruction 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 re-

mains that. Neither the term or 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. 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 transportation 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.

To say they belong together requires demonstrating the relatedness of all types of T-M entities. It is not enough to simply construct a work encompassing T-M forms. It is also necessary to stress the commonality of the aids along with the simultaneous independence of the forms and their unique characteristics. This theme of commonality can be demonstrated in a variety of ways. The theme can be explicit when dealing with semiotic and communication concepts, taxonomy, and holography.

Commonality is also present in less obstrusive ways which acually may be more pervasive. For example, the classifications highlight the individuality of T-M yet at the same time taxononomy ties T-M forms together by indicating shared characteristics. Vignettes of history and descriptive of T-M forms more than hint at shared backgrounds and parallel, developments. The over-all development of the monographs hopefully illuminates 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 became a household word. Despite the difference that the WWW has made, what was written in 1991 has more than a little truth to it. The Web is clogged with references to T-M but most of them run counter to the correct meaning of the term and the meaning of Transportation-Marking in the Library of Congress. There are also many sources for individual forms of safety aids and to transportation modes on the Web. But these are frequently fragmented and widely separated. The new Transportation Library Catalog (spring, 2004) may possiblyhelp to bring resources together yet the incorrect use of T -M may conceivably continue 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 holographic support 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 don't they 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 largely unknown to a larger world. For example, publications of the International Hydrographic Bureau, a key source in the past for buoyage ma-

terials, are found only a few libraries; even a variety of mariners may not be conversant with that literature. Nor are the publications of the International Association of Lighthouse Authoritaries (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. And most entries on the Web for Transportation-Markings point to surface markings.

It is not very likely that even a moderately well-stocked library possesses even some of the more essential works on T-M. And, therefore, it is unlikely that very many individuals would have knowledge of even some specialized publications let alone many of them. This suggests that even partial awareness of the nature and form of T-M would be possessed by few people. Readers with wide transportation interests may be acquainted with a few publications (as well as using some forms of T-M). Only the most general works -- which are usually of a technical nature -- will include even a mention of all forms of T-M forms. More specialized works often include a single area of T-M forms and perhaps only parts of a single area. And many, if not most, entries on the Web point to surface markings and related topics.

Further, specialists are generally concerned only with their discipline. They are rarely concerned with adjoining disciplines. Mariners, for example, many 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 of the misuse of the key term blocks the finding of linkages.

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 studies 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. For some T-M systems there have been many efforts at building common systems of aids through international bodies; other markings have achieved less global convergence. Nonetheless, an attempt has been made to draw together the many marking types from around the world. And this includes those forms whose source materials have been tailor-made, and those whose sources had to be woven together from many fragmented strands of materials.

The approach of this study could have 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 this disposition creates in the receiver). Or a communication form centering on physical signal processes (semiotics does not

involve the physical signal dimension to a notable degree). Or a study giving significant attention to holons and holarchy 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.T-M studies primarily follows an approach that is holistic and integrative and centers on communication theory, semiotic perspective and, more recently, holography concepts.

e) Underpinnings of T-M

The underpinnings of the several studies of this Monograph Series on Transportation-Marking 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, to 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 sentinel with square-ended blade in red and white in the Chehalis lowlands and a signal with pointed-end blade yel-low and black near Vader. And interspersed with the signals were little noticed targets, whistles, mileage posts, and station signs.

The panorama of marine, aero, rail signals and beacons of the northern Pacific coast, the River of the West, and the Puget-Cowlitz 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 con-sciousness since they conceivably became embedded in the subconsiousness of many users. A utilitarian object occasion-ally 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 far beyond the 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/Eurka)
January-September 1991

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

Revised Yet Again, Mt Angel & the Milk Ranch
2004

Prolegomena: Addenda

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

Professor John Hibbs (University of Central England), 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 transport. T-M can be defined as any device (external to a mode of transport) that aids a means of transport 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 transport modes. Traditionally safety aids are associated with a mode of transport far more than with other T-M forms. Railway signals, for example, are attached to trains and tracks, 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.

Yet an exclusively mode-specific approach to safety aids can have shortcomings. T-M forms are ultimately a form of communication and even of 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 provides

an additional perspective on safety aids rather than deny the traditional mode-related nature of conventional studies.

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 "coordinate[s] action by means of injunctions, instructions, notice or warnings". (Guiraud 1975, 45, 51).

Another important perspective for T-M is that of the communication model (Noth 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.

Nearly as important as semiotics and communications for T-M is the study of taxonomy. Dana's System of Mineralology (C. Palache, ed., 1944, Vol. I, 7th ed), 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 classifiations also indicates shared elements among T-M forms.

A final perspective is that of the holon, developed and described by Arthur Koestler (1967, 1978 and 1981). Holons manifest a double nature: holons are simultaenously semi-independent wholes and an integrated part of larger wholes. Each holon contains other holons and, in turn, is contained in other holons. Koestler describes holons as a vast hierarchy (more correctly termed a "holarchy") with each holon as "Janus- faced". "The face turned upward, toward the higher levels, is that of a dependent part; the face turned downward, towards its 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.

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

Many of the monographs admittedly take up a mode-specific approach (Parts C/D, E, F, G) as it is difficult to consider the whole subject in detail in a single integrated treaise. That approach is, however, kept within at least an informal semiotic framework and it is firmly grounded in taxonomy. The foundation monograph (Part A, 1991, 1999,

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), provides a perspective that draws together all of the elements of T-M. The database (Parts Ii-Iv, 1997-2001) provides succinct descriptions of the individual markings. It too, however, remains anchored in the overall concept.

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 constitutent elements. The end result is a term that encompasses all forms of safety aids including forms that incorporate "mark", "markers," or "marking" in their names.

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[Subsequent to this essay are two other titles that have significance: Wendy Leeds-Hurvitz's *Semiotics & Communications: Signs, Codes, Cultures* (Hillsdale (NJ): Lawrence Erlbaum Associates, Publishers, 1993). And Kim Kyong Liong's *Caged in Our Own Signs: A Book About Semiotics* (Norwood (NJ): Ablex Publishing, 1996).]

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 Transportation-Markings, 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 keynoted by a scurrying and even frantic rushing about, of throwing together systems, classifications, arrangements without much -- in many instances -- 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 drew 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 less ruminating occurred as the days, weeks, months went by. The framing for the structure at times seemed reasonable and 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. The beginnings of topsy-turvy began to appear.

Some building materials had to be imported: woods from far countries, and stone, and even some of the metal pieces. As these materials arrived there was no time to carefully and slow 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 nails 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 galvanizing dip. Warped and rusting these wings testified to haste 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 asymmetry; 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 Practitioners

This essay has existed mentally for quite sometime but it is only now prepared in a written form. 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 international airports, 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 practised and with considerable skill. It may be of little consequence that not all members of the family had the skill. 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 that are square, nails and screws neatly installed, woodwork that is artistic. But more basic is the ability to know what each symbol means and to create it in the concrete: a symbol becomes a door, a window, a roof beam. Symbols and what they represent and creating what they represent in the concrete is 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 windown and instead install the garage door in its place. When the happy home owner 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 cannot read symbols correctly."

--If the plumber can't read symbols well and thereby connects the toliet drain to the shower head the happy homeowner 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 more than an interest in picturesque structures but in what they do: represent dangers, give guidance, convey regulations by something else: that something else being a symbol in light, flashes, colors, sounds. 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 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 descriptive accounts then in semiotics and holarchy.

> "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.* 1997.

CHAPTER ONE

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

1A Semiotics

1A1 Introduction to Chapter One

There are several basic tools and perspectives at the core of the foundations of this study which can help to understandard the workings of T-M. These include semiotics, communications, holarchy, and taxonomy.

Semiotics provides a basic perspective for any form of communication with an emphasis on the mental processes of communication. Chapter 1A will examine semiotic concepts, foundations of messages of T-M and a survey of semiotics literature.

Semiotics, though important, does not provide a complete system for the understanding of a sign system (at least not for the requirements of this study). Specifically, it gives only scant attention to communication in its physical dimensions. Chapter 1B considers the more physical communication aspect of T-M. This consideration of the physical process can be seen through two prisms. The first is that of communication theory (more precisely, a mathematical model of communication). The other prism -- and perhaps surprizingly -- is a form of semiotics but one that studies objects not specifically a means of communications. This form of semiotics is pursued by several semiotic practitioners in the field including Roland Barthes who is the major

author on that topic for this study (Barthes 1988; see also Noth 1990).

Chapter 1C takes up a review of taxonomy. Taxonomy is a basic element for any form of study. It establishes basic rules of procedures and process. It creates an essential foundation for this study. It also provides linkage between transportation modes and constituent markings with the result that the hidden commonality of markings becomes visible. There are some forms of taxonomy in 1A that relate to messages rather than types of T-M forms.

Chapter 1D is a new addition to the study. It examines the role of holarchy in T-M. Holarchy has been developed by Arthur Koestler and while a late-comer to T-M it has become a major factor.

The topics of Chapter 1 are not fully compartmentalized. To some degree the topics intermingle and merge together. For example, the foundations of messages in 1C are not only a primary adjunct of semiotics but they also provide linkage between semiotics, communication, holarchy, and classification. And the semiotics of the object of Barthes is linked to "regular" semiotics and also to taxonomy and technology though technology is not a primary focus of this study.

1A2 Basic Semiotic Concepts

Semiotics is not a tightly organized and highly integrated discipline keynoted by a high level of consensus among its practitioners. Nevertheless, it is possible to make some general comments about semiotics adequate for this study.

Semiotics can be defined as "the doctrine, science or theory of signs" (Sebeok in Blonsky 1985, 466). It has also been defined simply as the study of signs. Others, including Guiraud, speak of it as the "the science which studies sign systems ... ." (Guiraud 1975, 1); a definition that fits well with a complex study such as that of T-M. Sebeok, in the above named study, notes further that semiotics is concerned with the "exchange of messages" and "of the sign systems that underlie them."(Sebeok in Blonsky 1985, 466). Sign systems include various types of codes and that is a pivotal term for T-M (Guiraud 1975, 51).

Within the semiotics matrix one of the essential terms is that of semiosis or sign process. Semiosis can include from three to as many as six components. Frequently there are three core factors: the sign, the object it refers to and the interpretant (Sebeok in Blonsky and other sources). Morris, a pivotal figure in the development of semiotics, varied the number of components in his works (Morris corpus; see also Hervey 1982, 47-48). Four elements plus signification appear to be a common to all of his formulations. Signfiication is a core element of semiosis for Morris though for Sebeok it is outside of semiosis though remaining an important element.

The sign (and by this is meant a mental process rather than a physical signal; Noth 1990, 174) stands for something else (the object), (Sless 1986, 9) and this leads to an interpretant. The interpretant creates a disposition to act in a given way. Signification is the meaning of the sign or message. For example, a red nun buoy stands for the starboard or right side of a channel. The buoy (its redness and nun-shape more than the physical buoy) is the sign; it stands for the side of the channel and the interpretant is that disposition to keep the edge of the channel to the right of the vessel. The signification of meaning is: keep that buoy to your right. A second

example would be a railway signal with three-aspects (each aspect representing a color and each aspect constituting a sign in semiotic terms). The green aspect, a sign, stands for a clear segment of track and it creates a disposition for a train crew to proceed through that section of track at the agreed upon maximum speed. The signification of green is that the track is free of obstructions.

One other important element in semiotics is that of codes. Guiraud has made a major contribution to this idea and A.A. Berger (Berger 1984, Chs 21-22) has commented on, and expanded the coverage of Guiraud. Noth also write at some length on codes (Noth 1990, 206ff). Leeds-Hurwitz contributes to the study of codes in her 1993 book on semiotics. Codes constitute a major sign system, and codes constitute many forms. The codes of interest for this study are what Guiraud terms logical codes and -- within that category -- the sub-category of practical codes . According to Guiraud "[t]he function of signals and programmes is to co-ordinate action by means of injunctions, instructions, notices or warnings." (Guiraud 1975, 51-53). Ship whistle codes, fire alarms, military signals, are also in the category of practical codes. An examination of codes centers on message systems rather on the physical signal.

Semiotics (including the dimension of semiosis, signification, and the sign system of codes) is a vital tool for understanding T-M even if it is not a complete procedure for viewing and understanding markings.

1A3 Foundations of Messages

To speak of foundations of messages suggests a simple continuation of semiotics and T-M, a linking of principles to practices. Yet messages are more than that; in fact foundations of messages constitutes a bridge linking semiotics, the physical signal, and the transportation mode together.

While it is appropriate to place the foundations of messages in the same sub-chapter as that of semiotics, this material also touches on all aspects of the study including that of taxonomy since the classification of messages is related 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 dialectical character about them: unchanging or changing; multiple message or a single message. All of the possibilities are combinations of one member of each of the two sets of the dialectic.

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

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

The changing message/single mesage (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 signal at a school may only operate during school hours, or a drawbridge signal may function only when the lift span is raised. The signal, when inoperative, creates a different pattern of traffic than when on.

An apparently contradictory nature may also seem present in the changing message/multiple message form (U3M). This category refers to situations where at least two distinct messages are found within a single marking. For example, the device known as a "traffic beacon" has an unchanging message yet two messages are displayed: one a flashing yellow indication denoting caution, the other, a flashing red indication denoting stop and then proceed only when the intersection is clear. A second example is the marine light known as a directional signal. It emits messages for two or three zones within a 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 1984 (2nd ed, 2004) monograph on traffic control devices it became apparent that some very different forms of markings were merged together in the UMSM category. The changes made in that category carried forward to further studies in the Series.

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

The unitary group can be further subdivided 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) represent "B" while a sign denoting the name of a town denotes the "C" form.

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

1B The Physical Dimensions of the Transportation-Marking

1B1 The Communication Model

While semiotics provides a valuable tool for any system of signs it gives only limited attention to the physical dimension that creates semiotic signs. This study of T-M requires two additional perspectives: a) communication theory, and b) the semiotics of the object. That form of semiotics includes objects not directly and deliberately means of communications. Roland Barthes has written an essay on the second perspective, the semiotics of the object ("Semantics of the Object" in *The Semiotics Challenge*, 1988). Noth's *Handbook* provides additional coverage.

Communication theory has many practitioners. One pair of practitioners frequently cited for communication theory -- and in particular a mathematical model of communication -- are Shannon & Weaver (Sless, Noth, et.al., invoke their work). Their mode, and other communication models, constitute a "communication chain" including an information source, transmitter, channel, receiver, and destination. Messages are defined as "a sequence of elementary symbols" and signals "are only the energetic or material vehicles of signs, their physical form," (Noth 1990, 174-175). A simple representation of the chain can take this appearance:

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IS-------T-------C--------R--------D
   /        /        /         /
   M        S        S         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.

Communication theory is important for T-M since that model is concerned with physical forms while semiotics centers on the mental process of the sign (that statement is somewhat of a simplification but essentially it holds true).

The above model includes signals which -- for the model -- are "the energetic or material vehicles of signs," though not the signs. The communication model with its information source and transmitter encompasses the total communication process though not the subject matter (Noth 1990, 174). It includes the element which produces and projects the T-M as well as the message or mental process. Both semiotics and communication theory are needed to better explain T-M and its working.

1B2 Semiotics of the Object

Barthes' semiotics of the object does not include T-M. Rather it examined and included objects that were not explicitly communication systems. It may be a misinterpretation of his work to include the T-M within that category of semiotics. Yet the model of semiotics of the object fits T-M in several ways. It also provides a means to include more of T-M within the discipline of semiotics.

Since Barthes' treatment is complex and very much in the mainstream of semiotic thought (especially the continental European form) this brief review may not fully convey the concept. Barthes' defines the object "as what is fabricated or produced; it is of finite substance, standardized, formed and normalized" (Barthes 1988, 181). The object is the focus of a

set of connotations, and a set of coordinates; the later are more important for this study.

The connotations are existential and technological. Existential is described by Barthes as "the appearance or existence of a thing which is non-human and which persists in existing, somewhat against us" Barthes 1988, 180). He cites Sartes in which objects external and outside the human person creates nausea, and Ionesco where a mass of objects invade and smoother the human (Barthes 1988, 180-181). This element does not have much bearing on this study.

The other connotations is that of the technological (with reference to the above definition of the object). Barthes sees the object as something generated in great quantities, as something very much involved with consumption (Barthes 1988, 181). While this form of semiotics may be removed from T-M, the inclusion of the technological via the object is important for this study since much of conventional semiotics omits the physical dimension.

Both of these connotations -- in a Barthian mode -- are more refined and semiotical than the needs of this study. But the concrete character of the object is a vital correction to a semiotics focusses on mental processes. More important is the second phase of his semiotics of the object: that of the two coordinates of the symbolic and of taxonomy.

The first coordinate, the symbolic, denotes the fact that every object serves as a signifier of something signified. The second, that of classification, has social significance for Barthes: "a certain classification of objects ... is imposed upon us or suggested by our society." (Barthes 1988, 184). While objects and classification so referred to are at variance with T-M yet the linking of object and classification by

Barthes may have a bear on T-M as objects and their use of classification. A primary goal of this and the other T-M studies is the uncovering of a pre-existing commonality and inter-connections.

Some forms of T-M have only limited relationship with the semiotics of the object of Barthes. For example, unlighted markings such as road signs and pavement markings nearly subsume non-sign objects into the physical sign. Various partially-lighted markings, such as lighthouses, and aero obstruction beacons, utilize both 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 even if the lighted portion is obscured portrays a semiotic message, a T-M message.

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

1C Taxonomy & Holarchy: Expressions of Singulars & Wholes & Transportation-Markings

1C1 Introduction

Taxonomy has been a long-enduring element of T-M. More recently Koestler's notion of holons and holarchy has been added. Taxonomy and holarchy each encompasses the individual T-M form and the totality of those forms and their

relationships. The notions are not synonyms though they overlap to some degree. They offer perspectives both paralleling and diverging from one another. However, they complement each other more than contradict. Taxonomy presents an arrangement, a system built up of the individual objects. Holarchy presents objects (holons) that are simultaneously wholes and components of larger wholes. Put imprecisely, taxonomy is an arrangement of objects while holarchy (or hierarchy) appears to consist of objects placed in an arrangement in which each holon is both nearly complete and also part of something larger.

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. Classification can both provide points of connection, and it can also uncover preexisting connections, and areas of commonality between and among markings.

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 and 2nd 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, an outline by type of marking, and an outline by nature of message. Parts C & 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 forms), and for each area of fixed markings (an Appendix in the 2nd ed. provides a general classification). Part E and Part F contain unitary classifications; that is, the entire classification is in one place rather than an incremental form by nature of marking. Part F also contains a variant form because of the many forms of signals. Messages can also be classified (see Ch 1A).

1C2 Nomenclature

The nomenclature or rules for naming and classifying T-M forms were established in 1969 and 1970. The classification system has been substantially influenced by the Dana System of Mineralology (Vol I, 7th edition, 1944, Charles Palache, et.al., eds). The Dana System employed numbers as well as names for mineral specimens (in contrast to many natural classifications that have names only; other classifications -- including those of libraries -- use numbers). The 8th edition of the System (*Dana's New Mineralogy, 1997)* continues the use of numbers though the numbers are set off by periods.

What is the rationale behind this nomenclature and classification schema? The schema adopted is not a "natural" pattern since there is no natural T-M arrangement; T-M is of the realm of the artificial. Hopefully, the adopted arrangement is not altogether arbitrary either. The system has four levels (each represented by a digit): mode of transportation; nature of marking; classes of markings (when applicable); and the individual marking. Because of the special nature of buoys and other floating aids to navigation, the marine mode of transportation has been divided into two parts.

Buoys are therefore represented by the number "1" and fixed aids by "2". Aero navigation aids adjoin marine and are alloted "3" (there are some resemblances between marine and aero; for example, *Readers' Guide to Periodic Literature* in some older volumes referred to "Aerial Lighthouses," Vols VI-X, 1922-1937). Traffic control devices are represented by "4" and rail signals, signs and marks by "5".

Other arrangements by mode of transportation are possible. Historically, road safety aids are probably the oldest followed by marine, rail, and aero. Yet there are other factors supporting the present arrangement: Marine aids are the most developed area of modern T-M forms. Many aero aids are unlighted or partially-lighted as is the case with marine, and many aids are electronic in nature for both aero and marine. One could also note that "beacons" are a major form of marine and aero aids while many rail and road aids are of the "signal" form. Therefore, marine, then aero then road and finally rail is a reasonable arrangement.

The nature of the message number is denoted by the second digit follows this arrangement: Fully-lighted visual messagers are represented by "1" (for example, rail and road signals). Partially-lighted markings are listed under "2". The original classification attempted to distinguish between over 50% lighted and those merely half-lighted. But that is a difficult, if not impossible, distinction. Perhaps some computerized process may be able to ascertain that a lighthouse, for example, is 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-unlighted. But in this preliminary study such distinctions are not possible.

Number "3" denotes unlighted markings (signs, pavement markings, buoys without sound or light mechanisms).

Accoustical signals are “4” in the classification and electronic devices are “5”. Markings with messages from two different categories are listed under “6”; for example. 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 are two or more groups of markings 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 this allows for up to ten members for a specific classification sequence. For a nun buoy in the international classification the total number is 1412: indicating it is a buoy that is unlighted (14), that it is the first member of a group of more than one type of unlighted buoys (141, Unlighted conical) and the “2” designates that it is a US nun buoy.

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. (Note: this classification is of types not messages while with traffic signs the type and message become closely united and can not be readily

“broken apart.” This has meant that the last digit does not represent individual signs since they are semiotic signs -- in some sense and to some degree -- more than physical signs and therefore the fourth digit becomes a referent to groups of signs. For example, under 442, Regulatory signs, there are several categories of signs for prohibitory purposes and each of these can be divided into sub-categories; for example, those dealing with turns are numbered 4423. 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 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

1C3 Holarchy

Arthur Koestler coined his terms Holon and Holarchy before there was a Transportation-Markings. Nevertheless, this researcher was slow to grasp the significance of the holon despite reading an account of holons and holarchy in Toulmin's *Return to Cosmology* (1982). Only in the last few years has the holon become a major element for T-M studies. Koestler wrote of hierarchy, holons, holarchies in *Ghost in the Machine* and in several other treatments. One such treatment is *Janus: A Summing Up* (1978).

This coverage will closely follow the Janus coverage. Koestler's ideas are complex and only certain aspects will be reviewed here. Two key words are parts and wholes. Koestler notes that the word "parts" suggests something that is a fragment, not complete, lacks 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.

Instead of an organism undergoing processes it is a "stratified hierarchy of sub-wholes." A diagram of inner-connected sub-wholes presents a picture 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 pejorative meaning for some if not many people therefore he 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).

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. Editorial remarks accompanying Janus speak of holons as having "a dual tendency to behave as quasi-independent wholes, asserting their individualities, but at the same time as integrated parts of larger wholes in the multi-levelled hierarchies of existence." (Koestler 1978, "Janus: A Summing Up").

Holons manifest considerable autonomy, are substantially self-regulating, 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 in one of many in that function. Each buoy or taxiway light is a holon but they are in turn part of the holon of airport lights, buoys in general which 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. This can suggest the place of codes in semiotics.

Notes on Sources

While this study contains a standard bibliography, a review of important basic sources for semiotics, communication, classification and holarchy may be an appropriate conclusion for this chapter.

Among semiotic works of note is that of *Theory of Semiotics* by Umberto Eco. It is more ambitious work than of Guiraud. It provides perspectives on semiotic phenomenon 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 well be able to apply basic notions to a specialized work. Though for this researcher, and this study, the work of Guiraud is more valuable.

Pierre Guiraud's *Semiotics* is a very compact work but written in an understandable manner and with a focus on the place of codes. Guiraud has been of more value for this study than any other semiotic. A.A. Berger of San Francisco State University has written a work of semiotics entitled, *Signs in Contemporary Culture.* Berger 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 (Ablex Publishing, 1996), and *Semiotics and Communications: Signs, Codes, Cultures* by Wendy Leeds-Hurwitz (Lawrence Erlbaum, 1993). Both give considerable attention to codes; this is especially true of Leeds-Hurwitz who devotes several chapters to the topic.

Two massive tomes can also be mentioned here: Winifried Noth's *Handbook of Semiotics*, and the *Encyclopedic Dictionary of Semiotics* edited by Thomas Sebeok in three tomes (volumes). 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 helps to sum up and survey his work has been written by Eugen Bauer. That essay, "Thomas Sebeok's Doctrine of Signs" appears in *Classics of Semiotics* edited by Martin Krampen. The essay includes a bibliographical sketch of Sebeok along an exposition of his work and an extensive bibliography.

A more general work in communication is that of the four-volume *International Encyclopedia of Communications* edited by Erik Barnouw (Oxford University Press). It includes semiotics and many other topics with connections to communications. The work of Shannon and Weaver, mentioned in many works, exists in a monograph entitled, *The Mathematical Theory of Communication* published in 1949 (reprint 1964).

There are not many works that include at length a wide range of T-M forms. One such work is the *Symbol Sourcebook: An Authoritative Guide to International Graphic Symbols* by Henry Dreyfuss. The work is not exhaustive though it comes closer to a full-length treatment than probably any other work. There was to be an ongoing symbol databank that would add to the symbols. But with the death of Dreyfuss the project was discontinued. Martin Krampen's "Signs and Symbols in Graphic Communications" (*Design Quarterly* #62, 1965, Rudolph Modley's "Graphic Symbols for World-wide Communication" (*Sign, Symbol, Image,* 1966) and *Handbook of Pictorial Symbols* provides coverage of many T-M 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 aspect of T-M in all modes is *Navigation: Land, Sea, Air, and Space* edited by Myron Kayton, 1990.

The primary source for the classification is the Dana *System of Mineralology* by Charles Palache, et.al. (Vol I, 1944). This edition, though perhaps dated for mineralology, is very adequate for the classification system. (and more so than newer editions of the System which omit the numerical dimension. The 7th edition was partially completed in 1944 with further volumes in 1951 and 1962. The 8th edition, 1997, was prepared by Richard V. Gaines and six other collaborators.

Koestler developed the idea of holon in *Ghost in the Machine*, 1967. It also receives attention in two later books: *Bricks to Babel: A Selection From 50 Years of His Writing, Chosen & With a New Commentary by the Author*, 1981, and *Janus: A Summing Up,* 1978. Toulmin's *Return to Cosmology: Postmodern Science & the Theology of Nature*, 1982, offers a succinct review of Koestler's holon and holarchy.

CHAPTER TWO

LIGHT & COLOR PROCESSES & VISUAL TRANSPORTATION-MARKINGS

2A Primer on Light & Color

2A1 Light: A Brief Review

Chapter 2 is a revision and enlargement of the same chapter from the 3rd edition (1999). This Chapter 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 uses and influences of color in T-M. References to sources will follow standard forms in some instances while in other cases references will be more general or simply refer to other monographs in the Series.

There are several elements involved in understanding the nature of lights and a reading of even a few authors presents a contradictory or, at the very least, paradoxical explanations.Divergent understandings can also display convergence as well.

Electromagnetic energy has several forms including that of light. The physical character of radio waves and of light are both forms of radiant energy (Murdoch 1985, 14; Bloembergen 1985, 655). Older theories about the character of light included ideas that light 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 19 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). 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.

But very early in the 20th century it was found that some properties of light cannot 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 disregarded 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 radiations. Those entities, though without color and non-reflecting, glowed more visibly as their temperature increased: temperatures changes 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 energy of emitted radiation is proportional to its frequency" (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 approach partly explains 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 relativity 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). Dualistic suggests a two-track form that manifests a closely united nature of two elements rather than two tracks combined into one. Murdoch notes that in an explanation of the processes of energy transmission the quantum theory (rather than Quantum Mechanics) better explains some of the portions of the process while the older electromagnetic process better explains the remainder of the process. Dualism, in this view, more adequately describes the process than a single element.

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 photon 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 theories 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).

Light is radiant energy. A more expansive definition is supplied by Murdoch: it is "visually evaluated radiant energy." Light is energy; it 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 electromagnetic spectrum that includes energy in a variety of wavelengths including radio, cosmic and x-rays. The wave-lengths that are visible to the unaided eye are termed light (Danger 1987, 36). And what is color? The sensations generated by specific wavelengths in the 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).

2A2 Introduction to Color

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 wavelength 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: 1/1,000,000 of a millimeter; ten millimeters= 1 centimeter = .03937 inches) (Murdoch 1985, 10). Cutler (1972, 13) has figures somewhat at variance with other sources: 400-450 nm violet; 450-500 nm blue; 500-570 nm green; 570-590 nm yellow; 590-620 nm orange; 620-700 red.

The process of human vision and the presence of color is complex. 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 receptors 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 instead 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 in his study entitled, *The Physiology*

of the Eye (1990, 399-400).

There are many physical, physiological, and psychological factors that affect the creation, transmission 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 material 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 four colors are primary for humans. (Birren in the places sited).

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, 144-151).

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, 144-151).

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 mirror 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.Ds., has achieved a prominent role and may supplant traditional and less than traditional forms.

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). One source claims only 5% of the energy is light while a second suggests 15%. (Carmanah; 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). These are incandescent lamps that employ a halogen group gas such as iodine or bromine. (Glossary). With the presence of iodine any tungsten evaporating from the filament will be regenerated and return to the filament. The cleaning or regeneration process adds to the life span of the lamp. (Technical Information). Halogen lamps experience a reduced level of darkening of the globe in contrast to conventional incandescent bulbs. (Lindsey 1991, 43-44). Halogen lamps manifest very good "color rendering." And they produce considerable wattage in a small envelope. (Lindsey 1991, 75). Many aero nav lights employ halogen lamps (e.g. ADB).

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 Part G, Part J). While discharge lights 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. (Kaufmann 1984, 8-52; 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). The energy for the flash comes from energy stored in a capacitor (Brooks 1983, 258).

The metal halide lamp is a form of discharge lighting; that is of high intensity discharge nature(mercury vapor and high pressure sodium are also of that form) (Brooks 1983 236-237; Glossary). Metal halide lamps include a ballast that allows the light to continue operation in contrast to the short-arc of xenon lights. Metal halide lamps including traces of metals that creates a white light of a daylight character, The

lamp can also produce a wide range of color hues. Metal halide lamps are long-lasting and efficient. A variety of aero beacons employ this technology. (venture-lighting.com; also electric lighting ...). Keeler 1987 viewed the metal halide 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).

L.E.D.s (light emitting diodes) have rapidly become a key form of light. Marine aids to navigation, traffic signals, railways signals are adopting this form of lighting. The L.E.D. is a tiny silicon chip requiring only an electrical current of limited power. 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.s at an installation (e.g. a traffic signal) require little energy. (Wikipedia; Carmanah-roadlights.com; MRSEC.wisc.edu).

An older light source, neon, finds some use for obstruction lighting. This is seemingly more often employed 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 lightings. (Part G, ICAO 1993, 128; manufacturers include ADB, Cegelec and Thorn Europhane).

2B Color & Transportation-Markings

2B1 Historical Development of Color Use in T-M

A survey of the development of color usage for T-M examines several issues: a) do color usages pre-date T-M and therefore come from other fields? b) do color usages originate in various scientific and technical disciplines? or c) do color usages emanate from T-M in itself?

A historical survey of color messages for T-M soon encounters a problem in examining possible pre-T-M messages. As 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 which may indicate whether or not messages corresponding to T-M messages 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 the researches of Dreyfuss found no evidence about yellow or green that suggests 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 reflects the use that green and red occupy in Eastern Hemisphere buoyage and beaconage markings (O'Dea 1959, 68). It can be noted that 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). 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 cheminstry, and the internal requirements of T-M.

Much of the work in color standards for T-M took place in the 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. Psychology has become 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 very similar to primary colors which suggests an influence from color studies. This is true even though some of the major work in color took place at the same time as developments in T-M colors uses were occurring. Nonetheless, the close parallels between the work of such research as Munsel and Ostwald indicates an influence upon T-M developments. Especially important is the Munsell color system since it fits in well with signal color systems especially those of railways (AARPAPOS, Ch 1).

Munsell's hues include red, green, yellow, blue and purple (Birren 1963, 148-149). It is perhaps telling that Munsell includes purple, unlike other systems, and that purple appears in railway color patterns though, admittedly, on a limited scale. Railway uses of color and Munsell's studies chronologically overlap. Ostwald's work is somewhat later yet some influence on T-M may be present.

In summary, what can be said of the impact of color and especially of color research on the T-M colors? While a cause and effect relationship would be difficult to establish probably some relationship is present. Signal colors and primary colors demonstrate considerable correlation. It is quite possible that those involved with transportation color usage (in an earlier stage) were familiar with the work of Munsell. While American railway literature does not provide details on any actual connection there is the tantalizing suggestion that railway colors -- which are the basis of many signal color systems -- are tied to the Munsell system. There is at present a large body of publications dealing with color standards and signal colors yet much of that literature came about after the establishing of colors.

Munsell's studies were less vision-orientated than those of Ostwald yet they had greater impact on color. This may indicate that Munsell's work took place about the same time as much 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 not primary colors (or at least not primary in all color systems: lunar-white, purple and what one railway calls orange [which may be within the limits of yellow]) (Swiss Federal Railways 1981; Part F, 1991, 117).

Color usage in T-M is not fully 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. 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 -- and psychology began in roughly the same era -- it is not responsible for 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 even 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 crept into the process or even that the agreement is on hold. Red with the meaning of danger or stop occurs in advertizing 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 scope of this monograph cannot not encompass the full range of T-M messages. But a review of general uses of color in T-M is possible. The first edition of Part A color usage was arranged by the transportation mode (aero, marine, rail, road). But in the 2nd ed to this edition the focus is instead on the color usage followed by reference to the mode. The modal monographs provide more detailed coverage. Color usage is not accompanied by references as the coverage ranges over a wide range of materials. Again, the 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. It also conjoined with the color white in aero approach lights.

Red can be employed with variant meanings that do not denote danger (at least in a direct sense). In marine aids to navigation red alternates with green as an indicator of the sides of channels rather than as a stop signal. Red is rarely used as a danger signal in marine navigation. A few major lights may have a red sector denoting a special region of danger near that light; that would constitute a standard meaning of red. Red is also found with directional lights (narrowly focussed lights of several colors delineating a multiple-channel). Seemingly, no other transportation mode employs a principal color in an atypical manner to this extent.

Red has the accepted meaning of stop in road and rail situations; most of the meaning 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. The use of multiple colors indicates qualified versions of more basic messages, or -- in the case of multiple-signal 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. There are a limited number of situations where 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 very much associated with a "go" message with the one major exception of 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.

For marine aids to navigation green shares the function described for red which is to mark the sides of channels. A possible point of confusion concerns which side is designated by green and which by 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).

Green in rail and road signals follows the format of the comments about red. The general meaning ascribed to that color comes from these signals. Green in rail use may appear by itself though it can appear with other colors which sometimes --but not always -- qualifies the basic message. Flashing and multiple green signals signify other nuanced meanings. The use of green for road signals follows a simple pattern with few qualifications (turn and lane signals offer some qualifications).

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. 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 employs yellow for cautionary messages. Rail signals have a more complex pattern of usage and the remarks for red and green can generally be applied to yellow

Red/Green/Yellow loom up very large in human consciousness for T-M colors. Yet white is a frequently employed color and in some instances eclipses apparently more commonly used colors. 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 sometimes with other colors.

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 is also a major color for structures. The new international buoyage system has probably decreased the use of white since the new system is more specific about color usage than previous systems and has increased the use of green and red.

Road signals colors do not include white. But many road pavement markings employ white as well as some signs. White is used for railway signals though on a restricted level. Some mainline signals display white messages though often for specialized purposes (e.g., switch/point indicators).

There are also some special forms of white in use. One of these is lunar white (sometimes termed blue white) used by some railways. A second special white is termed "variable source white" is found largely with aero lights which can vary intensity according to weather conditions and time of day. Changes in intensity alter color temperature 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. The most important of these is that of blue. It is used for taxiway light at airports, construction work, and derails on railways. Blue also finds limited use with road signs and pavement markings. Purple (often termed violet in Europe) has limited applications in railways. Purple 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 employed in some railways. It denotes a less saturated hue of yellow but remains within the spectrum of tolerances for yellow. The color orange employed by the Swiss Railways is within acceptable yellow boundaries. Orange in different hues than previously described forms are employed for some buoys and some older pedestrian signals. Some aero markings are also orange. Other colors include black and brown 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 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

1 The Development of Messages Before 1900

a) Before 1850

Quite obviously T-M before 1900, and even more before 1850, displays a truncated appearance. The aero mode did not exist and traffic signals were primitive and very much of a rarity before 1900. Only two modes were served by markings of a relatively complex nature. In the early 19th

century only marine markings amounted to very much at all. Traffic control devices were limited in scope and simple. Railway signals were in a primitive and embryonic stage. However, developments in color messages in one or two modes spill over into other modes and in time affect the total spectrum of T-M. To speak of color developments on the coasts of England and Scotland, for example, may seem a narrow topic yet it can have far-reaching results. This 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. White was preeminent in that system. The range of 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 color glass is not employed, can also create a difference in color. This is especially the case when a variety of fuels were used in early lights.

Despite the primitive state of early 19th century technology, including that of glass manufacturing, some marine lights exhibited color messages in that era and before. For example, Flamborough Head had a red and white color system in 1806 and this light also revolved. This may be the first light exhibit a two-color message, and also to 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).

Color studies were underway even 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 continues to find use with airport taxiway lights and slight employment in railway signals but not in marine lights.

Perhaps surprizingly, the first light in England with a color message displayed a green light not one of red. Surprizingly because green has a shorter viewing capability than red and rarely employed for coastal lights. That initial color light, the Smalls in UK, was a very early light: 1775. (Stevenson 1959, 281-282; and this is the reference for the next two paragraphs as well).

Color developments were very gradual but there were more extensive changes in light phase 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 the 20th century.

By 1850 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 second half of the century saw many more developments in light phase characteristics,

lens optics, and improved illuminants.

The first actual traffic signal was established in 1868. However, a primitive form of land signal for surface traffic already 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 Saint Botulph's Church in Boston, UK may constitute a third example of a "land lighthouse." Knowles refers to it as the "beacons of the fens." (Knowles 1976, 14).

Railways began working on signals early in the 19th century. Railways and signals began in England with many later developments in the US. The first signals may have been on the Liverpool & Manchester Railway in 1830. The earliest signals were much like current switch signals with targets. An early US signal 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 6-19).

By mid-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 though with a different meaning than the contemporary one. Green had limited use during the mid-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, but some embryonic underpinnings were becoming visible by mid-century

b) 1850-1900

1850-1900 stands as a vital transition period for T-M. It is the last period lacking aero navigation aids. It includes the most intense period of the crisis in railway signal color development. It represents the zenith of visual marine aids to navigation, and it includes the first traffic signals. But this is also a period of embryonic beginnings rather than fully completed solutions. The railway signal problem is not resolved until the first years of the new century, nor do seminal changes occur in marine aids until the 20th century. But that half-century is, nonetheless, a vital bridge between a 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 for caution, white for proceed. The original code (formulated at Liverpool before the mid-point of the century) had far reaching impact. This is is not surprizing since railways were

largely confined to the industrial nations of Europe, Japan, and North America; signal work in the UK thereby could affect much of that restricted railway network. (ARSPAPOS 1953, 73-74; also for following paragraphs).

Chappe Brothers, an English lighthouse engineering firm, determined that the colors of red, white, and green were more commonly used on railways than any other colors, and 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. It is not known if any form of yellow was tested.

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 lense 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 displayed a strong white lantern 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.

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 be less unacceptable than it first appears: symbols can become ingrained in human consciousness and what appears to be a conservative attitude is reasonable at least to some degree. To be sure, the status quo in itself was a potential safety hazard. b) The second explanation for the slowness of change was the unsolved problems of precise color definitions -- to 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.

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.

Late in the century the American Railway Association appeared to be almost literally groping in the dark as the hunt for a third color that could be used for a caution signal continued to be elusive (ARSPAPOS 1953, 74). Several colors were suggested for a caution signal including violet, blue and orange. Violet was presumed too close to 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 of 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. (ARSPAPOS 1953, 74).

The 19th century ended without a resolution of what may have appeared to be an intractable problem. The problem of deciding on 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 points 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 be possibly 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. At first there were only hazy outlines of how safety aids should function, Changes in colors and light phase characteristics were joined by advances in lighting illuminants, optical apparatus and mechanical equipment.

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 characteristic was added, as well as a form of pre-Morse code indication (flashes indicated agreed-upon numbers rather than letters). A quick-flashing characteristic joined the list of light phase 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 predominated 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 meanings. And the state of technological production has considerable 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. Technology during this time was frequently in one of two states: a prototype state which was outside of the market, and technology within the market but available on a mass-production basis. For example, optical apparatus for major lights was crafted on an individual basis during the 19th century. While fuel systems were perhaps less customized neither were they mass-produced. This meant that technological advances were available but at a slow pace and continued to be 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. (See also Part J, and mode-specific studies).

In the last decade of the 19th century various developments lead to a great diffusion of new technology: new liquid-fuel and vaporized-fuel lamps, the introduction of electricity and acetylene fuels, and the adding of automated equipment and timers. The older forms of markings may still have been in place but they were to be greatly altered in the new century (see especially Putnam 1913).

Most traffic signal developments occurred in the 20th century. Embryonic beginings can be traced to the 19th century. The first signal was in London and produced by a railway signal manufacturer. That underscores the relationship between road and rail colors and messages. The first

signal had messages of red for stop and green for go. Since UK railway interests early adopted green for go messages this practice was extended to road signals. UK had two-color signals and, hence, three clearly differentiated signals were less significant than in the US. Traffic signal usage did not include white. Other signals -- in a loose sense -- included red lanterns hung over holes in roads. This use of red adds to the evidence that red long held the meaning it has today (Mueller 1970b, 6).

2 The Development of Messages Since 1900

a) 1900-1925

Nearly any dates selected for beginning and ending a period of historical development can be arbitrary and artificial. Any case made for a chronological division could likely be made against that selection as well. The year of 1920 might be selected to mark the end of early modern developments in T-M yet many developments continued beyond that date. 1930 might be an adequate substitute except that many developments were completed by then (except for aero aids). The year of 1925 may be a more adequate ending date for the earlier 20th century except for aero aids whose formative periods extends to about 1930.

The resolution to a solution of the railway problem colors and meanings began in 1899 (Reference for this segment is ARSPAPOS 1953, 74-75, 78; 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 undertaken at Yale University by Professors Scripture and Churchill. Churchill 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. Some limited changes would occur over the years but these basic decisions held fast. In summary, these changes included the solution of the caution problem, introduction of an officially-sanctioned proceed indication and the addition of new colors for special uses.

For marine aids to navigation the changes of the late 19th century were continued in the new century. There was, as well, 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 character-

istics did not undergo significant change (USLHS 1918; Gibbs 1955, 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 well on to way to becoming a major fuel by World War I though not yet a dominant one. Two types of acetylene gas apparatus 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.

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.

Aero aids to navigation began even in the earliest years of aviation. Lighted letters (using prismatic reflectors and filaments lamps) were in use in 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.

A single individual, US Army Lieutenant Donald L. Bruner, is more responsible than any other person for the aero color code (Lipsner 1951, 201). Lieutenant Bruner, was an engineer in his pre-military days which, as it were, colored his army activities. He was greatly interested in night and topics impinging on that interest (Holland 1951, 67). His contributions to aero color messages virtually span the field. He helped to create the rotating airport beacon and worked on airway beacons. He focussed on the boundary lighting at airports (boundary lights preceded the employment of runway and threshold lights). Bruner selected white for perimeter lights, green for landing approaches and red for obstructions.

Bruner's use of colors and meanings paralleled uses in other T-M forms. In some sense he created an embryonic T-M discipline by recognizing and transferring developments from older transportation systems to the new one of aero navigation aids. His work also indicates the acceptance of specific colors and meanings by the 1920s.

By 1929 aero color messages had the following configurations: airport beacons exhibited a flashing combinanations 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.

Possibly the earliest traffic signal in the 20th century was one established in Paris in 1912 (Mueller 1970, 7-10). 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 denotingg impending light changes rather than a lighted message. 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.

The position of yellow to other colors in the signal housing varied. In some instances the yellow came after both the red and the 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 included 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.

b) Developments Since 1925

There have been major developments in many railway systems especially since World War II (ARSPAPOS 1953, 44-46, 70-71, 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 century and additional developments have been quite limited. There have been significant changes in the move from electromechanical 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.

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 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 that is "optically programmed" and which projects a color over a narrowly focussed area that cannot be seen unless the viewer is in direct line with it (this is reminiscent of marine range 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. Words on signal lenses have been omitted and words on pedestrian signal lenses are increasingly rare while graphic symbols are more commonplace (Mueller 1970, 13-16; cp the US MUTCD editions 1948, 1961, 1971, 1988, 2001).

Green has become more common in marine aids to navigration, and a wider ranger of light phase characteristics

are also available. IALA-generated changes (1980) affected color usage and increased standardization for buoys and beacons. However, most of the colors and meanings 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 the isophase (or equal interval) -- which was added earlier in Europe than in the US -- includes only those characteristics displaying equal measures of light and dark.

Aero nav 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.

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 blueused for taxiway lighting is known as "original 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 and -- as is the case with other airport lights --- uses a clear lamp with colored lens.

Approach lighting also began in about 1939 (Breckinridge 1955, 15; CAA 1958, 44). Two colors are employed: white and red. A typical approach lighting system has three phases: white bi-directional lights, followed by white/red lights, 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 meaning that can be ascribed to red.

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 stage they became omni-directional lights of a condenser-discharge or strobe nature. The color is known as "aviation variable white" and 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. While the survey has been too brief to cover all points hopefully it offers 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 accidential 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 TRANSPORTATION-MARKINGS

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 focussed overwhelmingly on visual forms. The 2nd edition rectified that omission. The acoustical coverage in that edition included an introductory statement for both light and color, and T-M and acoustical science concerns but the coverage of electronic forms did not. That omission is now corrected.

It is true that the 19th and early 20th centuries lacked electronic T-M forms. However, the past 75 or so years have seen a rapid development of those forms. That development has eclipsed and even replaced both visual and acoustical aids of many forms. This coverage, though brief, is needed to describe electronic processes and provide 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-Ms following 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 of the sources are of a "how to" nature though not including actual navigation systems. Other materials are of a handbook nature and simultaneous practical and abstract in content. Yet other treatises focus on navigation with an emphasize on the propagation of waves as well as transmitting and receiving equipment. The discipline of physics takes up these matters in more theoretical terms and therefore has a less direct 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 different form of energy matter). They 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 until (formerly termed cycle). A Hertz unit denotes signal frequency per second in cycles; for example, 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 wave 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)	

(References: Robinson 1985, Dodington 1982, Field 1985)

Legend: V=Very; L=Low; M=Medium; H=High; U=Ultra; S=Super; E=Extremely; F=Frequency; kHz=kiohertz; 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 characteristic 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 transmitters type 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 maintains a specific pattern. There are several forms. One common form is 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 (VLF, MF, etc.), and by radiation mode. The modes include elemental current, travelling wave, array, and apperture antennas. Radiation mode are determined by wave length and thence by frequency. The antenna has several parameters of which the radiation pattern is the most important and which heavily influences other characteristics of the antenna operation. The purpose of the antenna is to translate electrical energy into radiation energy (at the opposite end the 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 one 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 waves 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: skywaves and groundwaves (e.g. Appleyard 1985, 3). The groundwaves can be further divided into surface and space waves. The space wave can be further bifurcated into direct and skywaves (Horn 1989, 462). Whether waves are considered separately as subdivisions (and further subdivisions) all three forms are pertinent to this study. 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 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 ionosphere 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 is not intended to 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 focus of the monographs on marine and aero aids are the marking and the message systems rather than a specific focus such as electronics. This chapter focusses on electronics including the receiver: what process is used to convey the data and what is the receiver (initially a machine but ultimately the human user) seeing or hearing? This chapter brings together the electronic dimension of other studies and expands on them. The expansion of GPS to include rail and road navigation -- as well as aero and marine

forms-- is more present than in the time of the 3rd edition.

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.

Some of these classifications are seemingly contradictory while others are less than fully complete. This compiler offers an alternate classification to meet the needs of Transportation-Markings. The focus of this segment is the electronic character of messages and receivers which need to be placed within the context of T-M forms.

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

a) Multi-station at one location with multiple messages (MSOLMM).

b) Multi-station at multiple locations with single message (MSMLSM).

c) Single-station with single message (SSSM).

d) Single-station with multiple message (SSMM).

This approach includes marine and aero T-Ms and encompasses radar aids, satellite navigation as well as radio beacons and hyperbolic systems.

3B2 Electronic Signal Configurations & Receivers: Multi-Station at One Location with Single Message

The term "Hyperbolic" is interchangeable with that of the classifiction 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. This is also the largest segment of this study though GPS has attained greater significance in safety aids. 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 an intersecting pattern resulting in lines of position which indicates location for the ship or plane employing that system. It may be more workable to describe the operations of various hyperbolic devices rather than the hyperbolic processes with references to individual systems. Vignettes of system backgrounds are included in this study as they can provide a vital dimension for the individual markings.

Consul is an anomaly not only for hyperbolic systems but all electronic systems since it occupies divergent -- even apparently contradictory -- places in various classifications. Consul (the UK term) began as the German "Sonne" system in World War II. It is hyperbolic because it employs multiple stations yet it can be better 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 is employed both by aero and marine navigators. Cutler 1986, 1937, 1945-1946; also Consolan, BP-5).

Reception of Consul signals do not need special equipment. Lines of position can be picked up by radio direction finders or even regular commercial receivers. The receiver need only have 250-370 kHz capability. Readings are determined by measuring differences in reception of trans-

missions. Stations are three in number with a range from a minimum of 25-50 nautical miles (nmi) to a maximum of 500-1400 nmi (or 46-96 km to 926-2596 km).

A US version, termed Consolan, is very restricted in coverage. A 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.

Decca is a hyperbolic system with marine and aero applications. The stations include a master and 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. It transmits a continuous wave signal that is not modulated. It is a coastal aid that has a nominal range of 240 nmi (444) km). (Maloney 1985, 462; also Parts C & D, Volume I, 2nd ed.; and next par.).

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 until 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; this was a featured by the now-closed Omega system.

Loran-A is a hyperbolic system that is largely obsolescent. It was a primarily a ship navigation system though it had value for air navigation as well. Loran-A consists of a master and a slave station. Loran-A utilizes one of three frequencies: 1850, 1900 or 1950 kHz. The transmissions were in pulses (see Parts C & D; also older editions of USCG light lists, and editions of Federal Radionavigation Plans).

The receiver is somewhat similar to standard receivers though modified for Loran receptions. The receiver 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 station. A second reading is gained by utilizing the master and another slave station, or by the same stations if a double transmission exists. Maximum range was 800 nmi. (Previous sources).

Loran-C was the major hyperbolic system in use for some time and continues to find some usage. To some degree it was superior to Loran-A. However, Loran-C replicated that higher quality. Loran-C is a marine system that includes some aero navigaton use over oceans. A system known as Loran-B was developed but did not found practical usage.

Loran-C has a master and two or three slave stations. It operates on 90-110 kHz frequency. Loran-C transmits eight-pulses per transmission (Loran-A had one pulse). LF achieves transmission syncronization expandings 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 of Loran-A (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.

Omega was a truly global system during its years of operation. It operated on a VLF frequence spectrum of 10.2 to 13.6 kHz. Omega consisted of just stations world-wide. The stations transmitted timed pulses at four frequencies of 10.2, 11.3, 13.6, and 110.05 kHz. The eight stations did not follow a master-slave pattern. Range was virtually without limits (Robinson 1985, 37-3; see also 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 can be used to gain the necessary data. Omega was closed down in 1997 (FRP 1996, 1-11; FRP 1999, 1-10).

Toran is regarded by some navigation sources as a hydrographic aid and by others sources as an aid to navigation. 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 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 satellite systems included Lorsat and Starfix. A Soviet system, Cicada, was similar in operation to Transit. (Robinson 1985, 37-6; see also FRP).

Increasingly Global Positioning System (GPS) and a system for supplying corrections for precise navigation have become of critical significance for navigation. GPS can be regarded as a multiple station system with one a single message. It is therefore not hyperbolic but instead employs a pseudo-range and time measurement system. With some two dozen satellites systems in place it supplies global needs. The signals use frequencies of 1575.42 MHz 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 systems that allow even the landing of aircraft within narrow parameters. GPS and DGPS already offer easily read information for pedestrians, hikers as well as increasing range of data for all modes of transportation. (FRP 1999, 1-9; National Civilian 2000, 5; Modern Magellan 1998, 63).

3B3 Electronic Signal Configurations & Receivers: Multiple-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 System (ILS) and Microwave Landing Systems (MLS).

Instrument Landing Systems (ILS) is a long-established that was intended to be replaced by the Microwave Land- ing System (MLS). 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, 2nd ed; 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) provides azimuth guidance. The antennas have a 90 Hz left-hand pattern that is modulated, and a 150 Hz right-hand pattern that is also modulated. The receiver contains a "course deviation indicator" (cdi) with two needles. If a plane is to the left of the course centerline the receiver picsk up the 90 Hz signal and the needle moves or deviates to the right. If the plane is to the right of the course then the 150 Hz signal is detected which moves the needle to the left. The localizer broadcasts on 109-112 MHz frequency spectrum.

The Glide Slope -- located 1000 feet past the approach end of the runway and off to one side of the runway -- broad-casts on a frequency between 328.6 and 335.4 MHz. This unit provides altitude information. For example, if the plane is flying too low then the appropriate needle (which is on a horizontal plane) will point upward; if too high then it points downward.

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 receivers 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 for the highest category ILS; the third denotes decision height at lower category airports. A fourth beacon may be in operation of non-precision airports. The incoming signals are combinations or dots and/or dashes that differentiate between the beacons.

The Microwave Landing System broadcast 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 location 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 station units, both single and multiple message forms, are fewer in number and scope than multiple station units; it is therefore feasible to discuss both in one segment. This category needs to be qualified since some single units may sometimes 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 but largely for ship- and plane-based uses. Written sources on radio-navigation often do not include ground-based radar systems. However, such systems exist though of more limited scope. Objects known as radar reflectors are commonplace in marine navigation though not actual radar devices: they are passive rather than active devices. Radar reflectors are objects so shaped that shipboard radar can more easily spot and identify 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 systems. Racons can transmit either coded 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, 233-234; also Kennedy 1985, 609; and Parts C & D, 2nd ed; also following paragraphs).

Ramarks are a primary form of radar since they do not require a receiver to "ignite" their transmissions. Ramarks broadcast an omni-directional 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." The frequency of the beacon is either the spectrum of marine radar frequencies (3 GHz or 10 GHz), or of the "beacon band" which is slightly less than 10 GHz.

Radiobeacons (termed Non-directional Beacons, NDB, for aero usage) are a LF and MF electronic device. Transmissions 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) pattern or a continuous wave that has been modulated. Marine forms transmit dots and dashes in patterns similar to light characteristics though in a differ- ent energy form. Receivers are radio direction finders which constitute a special form of radio receiver accompanied by a directional antenna.

The remaining units create some measure of confusion: VOR, DME, Tacan, Vortac. The first two are separate units that are often collocated; Tacan is a primarily military system that includes VOR and DME functions and VOR brings together both civil and military electronic systems (See Part

B, Vol I, 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 omn-directional. The receiver determines bearing by measuring the phase difference 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 array with the transmitter (Dodington 1982, 25-86).

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 pulsed signal to the transponder which in turn transmits a signal that can be identified by the interrogater. 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, 37-4, 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 PROCESS & ACOUSTICAL TRANSPORTATION-MARKINGS

4A Primer on Acoustical Processes

4A1 Introduction & Terminology

Acoustical processes and resulting T-Ms, though not a large topic, needs review in this study. This reviews includes includes a variety of topics even if only tersely. Acoustical processes begins with a primer analogous to those for light, electronics and design. Chapter 4A is divided between an introduction and definitions, and a explanation of acoustical processes. Chapter 4B examines the types of sound signals, messages, and impediments to reception of messages.

Marine aids to navigation have historically included 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. And audible pedestrian signals have become more common. Sound signals also include some electronic mechanisms which translate electromagnetic energy into audio signals at the receiver end. This topic is treated in Chapter 3.

Acoustics is the science of sound. Sound is mechanical energy that radiates through a medium (water, air, etc.) and created by a vibrating object (Albers 1965, 1-2). The mechanical radiation of sound waves is an energy form distinct from the electromagnetic radiation 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 psycho-acoustics as a branch field. Pschoacoustics includes the reception of sound energy or the hearing aspect of the process. (Lindsay 1966, 2-3).

Giancoli (1988, 382) notes that sound follows a three-part process: a vibrating object 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 represent a trans-mission 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 2001, 3-4). Truax notes that this model is the basis of most treatments of sound though other treatments may be less understandable.

Truax's major focus, a communication approach focussing on the movement of information rather than on energy, has less significance for this study than his prefatory remarks on energy transfer. The following segment provides a exposition in both brief and more technical forms.

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 occur-ence, the degree of efficiency, and factors that can alter the process. The energy begins with an object that vibrates and thereby radiating the created energy to a medium (air, water, a solid object, etc). The radiated energy is propagated through that medium thereby displaying various character-istics including velocity and frequency (Truax 2001, 4).

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 (approxi-mating 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 ocscillation. 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 wave 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. 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. Frequency 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: 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 the medium is a result of the frequency and of the velocity (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. 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 one medium can be at variance with that of another medium. And 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 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 mesured 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 cannot 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 20 Hz to 20,000 Hz. The ultrasonic frequencies 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

The examination of sound signals was slanted toward marine aids in previous editions. That is also true in this edition though the coverage tends toward the muted since so many marine fog signals are out of operation. A review of the forms and messages remains importance though it speaks much to the past. Audible pedestrian signals are becoming more common and are included in this edition.

The vibrating process and the resulting sound (tone, loudness, pitch) can be created through a variety of means. The means, and technological configuration, may not appear to be very important for 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 this century (the following examples are drawn from US Pacific Coast; though examples from other realms are available) a whistle fog signal (fixed location) entry in a Light List not only listed the energy from (often steam), but the length of the trumpet as well (often 12" in length though sometimes 10"; US Lighthouse Service, *Light List*, 1918; also next par.). 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 class as well (very often 3rd class). Fixed lights were divided into orders. This practice had practical value since, for example, a first-order lens (920 mm/36" in diameter) was very different in visual effect from a sixth-order lens (150 mm/just under 6") but 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 (see previous source).

But contemporary practice has devolved to a point where fixed fog signals are sirens, diaphones or diaphragms/ diaphragm horns. 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 feature. The fine print in a marine list of aids to navigation may indicate the propulsion sources). The USCG A/N Manual speaks of sound signals without reference to the form of vibration. Automatic Power [now merged with Pharos Marine] does list the form of vibrations (USCG 1990, 7-1 ff; Pharos Marine ca. 1989).

Possibly the most unusual form of fog signal is that of explosive charges, That fog signal is also largely in the past. This was a major signal in the United Kingdom. This form of percussion signal usually required human operation. Explosive charges have also been employed on railways and may possibly be still in use. Quite possibly this too was more common in UK and systems influenced by UK than in other systems. (Parts C/D; Parts Ii and Iiii; Part J; IALA 1970; Maloney 1985; Bowditch 1966; Renton 2001).

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 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 often accompanied by fog. A sea-activated gong, whistle, or bell buoy may create a clangorous situation when the need is less.

Bells and gongs are activated by tappers not clappers (a point that might generate a semantic controversy) since the bell or going 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-shaped containers grouped together (if that suggests the orient there is a reason: gongs for British buoys at an early date were imported from China; EB 1911, 647). Whistle buoys have a more complex system. Wave action causes air to move up and down the counterweight 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, Chapter 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). It is debatable to what degree simulated sound is similar to older forms.

Other forms of fog signals require either the passage of air or steam or an electromagnetic 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 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 message patterns are different.(IALA 1970, Ch 3; see also DMA N.O. #114, 1983; USCG Manual, Light Lists. These are sources for the following paragraph as well).

Diaphones, now rarely used, consists 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 fog signal, the nautophone, created a sound similar to the reed but through a diaphragm process

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. That other form was the sub-marine bell and the variant form of the submarine oscillator. This signal rested on the sea bottom and was attached to a lighthship 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).

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 is also mechan-ical) a programmed plunger hits the gong (Westinghouse

Brake & Signal, Australia, 1983 Catalogue).

A relatively new sound signal is that of the audible pedestrian signal. Possibly the first such signal was in Portland, Oregon in 1948. 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 also been employed in Portland (Kloos 2001). In the eastern US many 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 designate north-south corssings. (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). [From Part J, pages 180-181].

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 the only 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 but that 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 (see previous reference).

It may be better to speak of the energy source and assume it is involved with mechanical means unless otherwise noted. That avoids a second area of ambiguity: a sound instrument that is indirectly mechanical though not directly so. An example of this would be an air-powered signal in which a mechanical system creates a movement of air against a reed which creates a sound that is technically not mechanical by process since the source of energy does not directly activate a mechanical system creating a sound.

4B2 Messages & Impediments

Messages for acoustical signals can be divided into categories of regular and random characteristics for marine markings. Road and rail T-M forms require a third category: sound signals that are regular but without individual characteristics. Therefore, the regular category can be divided into regular-universal (no set configurations) and regular-programmed (specific configurations).

The US Coast Guard has only 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 become less varied in both types and sizes of vibrating instruments and distinguishing characteristics are increasingly important. Fog signals, even if in reduced numbers, continue to carry out a mission of providing a loud and raucous sound for mariners (USCG Light Lists, USCG Manual).

Road and rail T-M bells (those found at railway crossings) can be regarded as either a road or rail signal or both;

TCD and railways both include the topic. The bells of whatever form provide an insistent and staccatto sound that emits more than a 100 strokes per minute; some forms sound off more than 200 times per minute (WBAS 1983).

Railway cab signals, primarily a visual indicator, can be accompanied by a supplementary bell. Some aero electronic aids are translated not into visual images but sound manifestations as well.

Accoustical indications in road, rail and aero forms can be viewed as ultra-short range and short-range T-M forms. A range of inches, feet or yards reduces or eliminates the problem of impediments for reception of such signals. But 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 those using air. Water is more dense than gases but it is also more elastic than air thereby allowing for greater velocity and a more consistent, reliable medium. But other factors doomed the submarine bell. Ships needed sensors attached sound signals 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 variations of sound quality. Fog signals are important though they have limitations. They function as warning devices not directional devices.

CHAPTER FIVE

TRANSPORTATION-MARKINGS & DESIGN

5A Design, Culture and T-M

5A1 Introduction

The original foundational monograph (lst edition, 1981) lacked a design chapter. 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 (1999).

Design may seem a peripheral -- even 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.

A major change in this 4th edition is the addition of a sub-chapter on design, culture, and T-M. The previous editions focussed directly on T-M and design but omitted a general treatment or primer on design 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.

In addition to Chapter 5A there are two other sub-

chapters. Chapter 5B, external and internal factors in T-M, substantially follows the pattern of previous editions as does Chapter 5C which reviews T-M as a reflection of culture through the perspective of design. The sub-chapters of 5A-5B-5C-5D of the 3rd edition have been reformulated into the two subchapters of 5B and 5C for this edition.

5A2 Primer on Design

a) Terminology

The core term for this coverage is, of course, Design. Other terms including Fashion, Style and Culture are also reviewed. While the terms may be few in number the possible definitions and descriptions for those terms are numerous. Even though the definitions may be elusive, and even, contradictory, a review of terms may provide a measure of illumination and clarity.

Design can have diverse definitions, though a substantial number can be reduced to a two-fold 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 ... ." (Design. Wikipedia). While the "[t]the noun is either the finalized plan of action or the result of following that plan of action." More simply, design is process or product (Lawson 1997, 3; and S & S 1983,1).

A more complex description is given by Walker who provides a four-fold explication of design that unfolds the implicit meanings of the noun/verb perspective: "... 'design' causes ambiguities because it has more than 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 those that focus on the appearance. For example, Lauer 1990 speaks of "the planned arrangement of elements to form a visual pattern." Since Lauer includes finished products the definition may be broader in scope than appearances might suggest. (Lauer 1990, 2). Dorothea Malcom 1972 offers a second version: a design is a relating of elements and the creating of a visual arrangement that presents "an interesting unity ... ." (Malcom 1972, 7).

T-M, in a design perspective, focusses 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. However, the study of design and T-M ends where the actual designing of T-M designed objects begins.

The term Fashion is not as vital to this study as Design yet it has a role. Fashion can easily conjure up images of the latest fashion creations in New York and Paris. It can also include not only fashionable clothes but objects well removed from clothing. IESS offers a dozen examples of "fashion" from painting to writing, entertainment, varius forms of sciences, math (IESS 1968, 5, 342). Walker describes fashion as "many forms of human behavior" though clothes are pre-eminent. (Walker 1989, 171).

Fashion can be viewed negatively: "A fashion consists of a current (constant change) trend, favoured for frivolous rather than logical or intellectual reasons." (Fashion. Wikipedia). But fashion can 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. Fashion is a major component of life and, at the least, implicitly positive. (Brown, salon.com 1999).

A third term, Style, seemingly receives less attention in a design context by many writers. Walker 1989, by contrast, devotes considerable attention to style that includes reference to a definition of style by 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 the 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 Times 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 also doubted the 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 is "a prevailing custom or style of dress." However, fashion has a short life span and can be viewed as a fad or vogue. Style, on the other hand, 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 grammar 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 ... into productive patterns of work, lesiure and institutions." (Dormer 1990, 19).

The next term, Culture, is a different kind of term than the previous ones. Culture and popular culture are words that find frequent use though with greatly varying meanings. A working definition of culture is needed in this study since T-M as a reflection of culture is a focus of the study. Kroeber and associates uncovered nearly 300 definitions of culture. (Seymour-Smith 1986, 65). Reece McGee, influenced by Clyde Kluckholn, defines: "... culture [as] an historically derived system of explicit and implicit designs for living which tend to be shared by all or specifically designated members of a group or a society." (McGee 1972, 21, 176). "Designs for living" is at the core of the definition and includes what people wear, where they live, objects they use. And those objects are shaped by the cultural system and reflect that culture as will be noted in 5A c).

Two final terms having bearing on design and on T-M are minimalism and functionalism. Minimalism frequently refers to sculpture and not quite as often to painting in the 1950s and 1960s. Simplicity displayed through geometric form was a marked characteristic of minimalism. The term

minimal art is more commonplace than minimalism. Not infrequently sources beginning with minimalism move to minimal art. Sources also employ minimalism for music and under that title. Rarely is the term expanded to other design forms. An exception is McIlhany 1970 who employs the term minimal art (and also minimal form) but expands it to design of all forms including consumer, industrial forms. Minimalism can be applied to forms of small dimensions or encompassing dimensions but in a second-skin form. (Minimalism/Minimal Art: WWW sources: *Columbia Encyclopedia* 2001; Wikipedia; Artmovements; Artlex. Print : McIllhany 1970, 72-73, NOAD 2001, 1087).

Functionalism can be defined simply as design whose form follows function. This reflects the idea that a designed object's design is dictated by its function. Louis Sullivan, an early proponent, did state that "form ever follows function." However, G. Marcus claims he meant "forms express function." (Marcus 1995, 10-13). Functionalism has to with adapting the form to its function and environment. The term was to take on a narrower meaning in the 1930s when it increasingly referred to buildings following specific characteristics (often keynoted by concrete, glass, flat roofs). (Marcus 1995, 12). But a broader meaning remains valid. Functionalism, the philosophy undergirding functional design, was a key notion of the 20th century. And it is important in this study though with a more general meaning. (NOAD 2001, 1087, 687; Ferebee 1970, 78; Michl 1997).

A final remark on terms and their relationship is supplied by Alyson Ward in an article on clothing for the 2004 Summer Olympics. She refers to "form, function and fashion" and also to "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, even timeless concepts. That offers a vital 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 can vary with authors and designers. though there are usually about a half-dozen elements. They include line, value, color, shape and form, texture, space. Principles of design can include balance, rhythm, emphasis, unity. The arranging of elements can be of similar and/or different elements. A unity is achieved with an arrangement of elements and principles and that constitutes a design. (Malcom 1972, 7, 20, 76; Samuelson & Stoops 1983, 35 [hereafter S & S]; Ballinger 1965, 26-37).

The most employed element is that of the line. A line is a recording of movement and it "is the path of a point moving through space." (S & S 1983, 35-38). Designs ranging from graphic symbols to drawings, marks, diagrams employ lines. Lines, in turn, generate the elements of space and shape. Lines are the starting point of design elements and may be the only employed element. The element of Value refers to gradations of color density: the contrasts of dark and light in varied permutations. A third element, Color, can generate many variations, combinations. Human emotions, moods can be seen through color in design. (S & S 1983, 35-38, 40-43, 45-47).

Other elements include shape, form, texture, space. Shape is a two-dimensional form enclosed through the use of a line (e.g. a circle). Form is 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 suface quality with the composition indicated by tactile encounter. (Malcom 1972, 64; S & S 1983, 58-60, 69-70). Space has been described as "the boundless expanse within which all things are contained." Space constitutes "an exceedingly elastic environment ready to receive line, shape, form, value, color and texture." (S & S 1983, 69-70; Ballinger 1965, 26).

Principles of design include balance, rhythm, emphasis, unity, movement, contrast. Balance suggests stability. It can take a symmetrical or an asymetrical form. Some forms of design, whether schools or periods, focus on symmetrical forms while others tend toward a less symmetrical balance. (Ballinger 1965, 27). Rhythm employs repetitions in one or other form. These can be continuous, intermittent or follow an alternating pattern. Rhythm can also be termed repetition in which the rhythm of design is the operational principle. (Malcom 1972, 92; Ballinger 1965, 28). The principle of emphasis includes a greater focus on some portion of a design through the use of color, line, size, contrast. Unity indicates a "satisfying sense of relationship" through the use and interrelationship of the various elements employed. (Ballinger 1965, 29).

The final principles are movement and contrast. 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 goes so far as to say that "an artist controls and forces this movement of our eyes ... ." (Malcom 1972, 86). Contrast can be viewed as a separate pinrciple though it is possibly subsumed within the princple of emphasis. It denotes contrast through changes in density of color or shape, size, texture. (Malcom 1972, 104).

c) T-M, Design & Culture

In 1955 James Gibbs (a West Coast maritime historian) remarked that "Conventional light 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, solidness, bulkiness, 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 21st century whether in society, popular culture or specialized design at the periphery of the mainstream.

In a www.salon.com interview Holly Brubach offers reflections from her book, *A Dedicated Follower of Fashion.* that expands the idea of the influence of popular culture and design. She notes that "[f]ashion is in fact architecture's feminine counterpart ... ." "Buildings and clothes are the primary components of our everyday landscape, and they embody the ideas and the attitudes of the time in which we live." (Brubach in Brown, www.salon.com. 1999). Brubach's scope of interest 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 always be easy to explain how this process takes place but it does take place.

Ferebee notes that designers not only bring together the elements that result in a design but they also create statements that provide "a key to understanding the culture from which they emerge." 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 thereby influence, shape and, to some degree, provide a structure and foundation for this coverage of the design and interaction of design and culture for the T-M phenomenon and the messages and their meaning.

A scholar in cultural anthropology, semiotics, or design may be able to disassemble and delineate how cultural factors shape attitudes and objects which thereby become reflectors and indicators of culture that can applied to a specific entity. However, this writer can offer little more than a brief note that T-M is not an isolated monad 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.

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 historian of design. A history in capsule form by an amateur is a far greater challenge. But that effort is necessary in order to create a context for T-M within design and culture. At the least primary salient features can be suggested. A simple schema of the Victorian Era (to 1901) and the 20th century divided into periods of 1901-1950 and 1951-2000 might be a plausible schema for this review. Yet other formats are possible including a multifaceted one of 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. That more complex five-fold format will be followed here. The period after World War II lacks a name since no primary theme exists.

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 industrial procuedures as the century unfolded. (see Part J, Ch. 1B).

Ferebee terms this development as the "Industrial Age of Design" and notes how the accession of Victoria Regina and making of goods occured nearly simultaneously. The time of a products made by hand was to gradually fade 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 assembling of parts that could be interchanged on an assembly line moving continuously (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; Part J, Chapter 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 manufactured in large quantities. (Yarwood 1989, 895). Earlier green house (or glasshouses) developments were prototypes for the Crystal Palace. (Dixon & Multhesius 1985, 96-98). The structure was originally termed "styleless" since it lacked neither Greek or Gothic features. The stark geometric design would become in time 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 construction in London was influenced by the Crystal Palace and other designs. For example, King's Cross Station -- especially the train sheds -- were so influenced and began construction at about the same time as that of the Cyrstal Palace. King's Cross was an even larger structure that the Crystal Palace. 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 stupefying 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, meanings, ways of viewing design. The first, Art Noveau may be regarded as a kind of transition state and includes the latter part of the era of Queen Victoria and continued on to World War I or nearly so. Following Art Noveau are the starkly functional world of Bauhaus and the more decorative curvature world of Art Deco. The latter movements overlap both in time and regions. A brief sketch can do little more than name names, add dates and give a few hints of what those movements represented. Even such a brief review presents a context for design and T-M.

Art Noveau occupies a period of time in the late 19th century and early 20th century. It is variously dated as beginning between 1880 and 1894 and ending from 1910 to 1914. (Ferebee 1970, 56; Derville 2002; Lampugnani 1986, 19). The name has the meaning of "new art." The name originated with a 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 design

is focussed on outlines (often curved) rather than "surface decoration". (Ferebee 1970, 56). The use of curves often employed a "whiplash S-curve" that suggested botantical 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 more 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).

The Bauhaus movement, 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 of Bauhaus were marked by simplicity, the use of technology. There was to be 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 to the present 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). The name is an abbreviated form 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). 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) describe Art Deco. That exposition "sought to combine the ambitions of the earlier Arts and Crafts Movement with industrial technology." (Art Deco. Zimney). Some view Art Deco as having two phases: an earlier and more complex character and a later (after the beginnings of the Depression) simpler, unadorned style. (Art Deco. Zimney). Others confine the term Art Deco to the earlier period and the term Modernist or Streamline Moderne to the later period. (Art Deco. Decopix).

Earlier Art Deco included ornamentation employing geometric forms and 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

One can speak of Victorian or Art Noveau or Art Deco design. But to name a style or a 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." And, "[t]here is no dominant style, no prevailing trend." (Muschamp 1998, 61). John Walker, an English scholar, asked the question in the 1980s, "[i]s 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 be little more than a glance at post-World War II design. It can outline some events, trends though falling short of a definitive or comprehensive review. The nearly 60-year period of time can be divided into general remarks to the mid-1970s, and more specific remarks from the mid-1970s to 2000.

Stoops & Samuelson note the lack of a school or dominant style of design in the post-World War II era as well as the key features of that time. 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 commonplace. (S & S 1983, 135, 136). These were often synthetics that included plastics (also known as synthetic polymers) including, polyurethane, acrylics, polycarbonates) and fiberglass (glass-reinforced plastic). (Plastic. Wikipedia). 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 throughout the era and at an accelerating pace. (S & S 1983, 136, 138; Part J, 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. Minimalism 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 McIllany 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 ... ." (McIllany 1970, 72-73). In contrast to a variety of other writers who begin with and remain with minimal art, he expands it well beyond that. McIllany 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." (McIllany 1970, 72-73). Design may have greatly changed since 1970 but McIllany's views continue to contain considerable truth down to the present.

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 the body but stretched to a thin membrane of spandex-altered cloth. Such membranes can be termed second-skins. Buildings and other designed objects can also have second-skins. (Dyett 1993, 8A). Minimalism can also refer simply to reduced covering. A basic form of this minimalism is noted by Margaret Visser. In an essay on swimsuits she observes that one of the few notable fashion changes in many years was the hip-baring swimsuit of the early 1970s which substantially uncovered the body below the natural waist. This suit was the one-piece version 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, admittedly, neo-

historical forms have become more common in architecture and have overshadowed at times older streamlined buildings and other objects. (Functionalism. Michl 2003; Ferebee 1970, 8). Yet form does follows closely the function of many objects from space craft to computers. The supposed minimal shape of a 1970 computer now appears boxy and bulky. Recent flat-screen technology has reduced monitors and tv screens to a near-non-existent state. A foot deep machine has often been reduced to a very few inches. (Fulford 2003; Abbot 2003; What is ... ICT 2004). A new Apple computer, iMac G5, displays a 2 inch wide screen whose casing contains the entire "supercomputer." At least one news account refers to the design as minimalist. It is both that and a matter of form following function. (Taylor, The Ipod's Big Brother. *Time.* 9-13-04; see also Stone, Getting Imac Right. *Newsweek.* 9-13-04). Perhaps minimalism can be seen as a primary approach to design even when design forms are quite diverse.

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 of the decade. And it was indeed a diverse collection ranging from water bottles to string bikinis to back packs, designer jeans, soccer balls, food processors. At least some of the objects could be classified as cultural icons. (Time Capsule, *Life*, 12-79). The Montreal Museum of Archaeology and History produced a collection of "20 Objects from the 20th Century" and many, if not all, can be termed cultural icons as they were viewed as "the objects most representative of the 20th century." They include predictable objects such as automobile, airplane, electric light bulb, jeans and less predictable objects such as the plastic garbage bag. (www. musee-pointe ... .).

Out of the welter of designed objects are there a few objects that could qualify as cultural icons? If reduced to just two objects one might suggest blue jeans, and computers (A.A. Berger's treatise on Material Culture focusses on fashion with a specific emphasis on one object: blue jeans; Berger 1992, 7, 8, 13). Blue jeans have ebbed and flowed over a half-century and more but of late they loom up very large on a popular cultural horizon. Denim Glossary claimed over a half-billion pairs of jeans had been sold in the US in a single year in the mid-1990s. (Denim. Denim Glossary 1997). Plain jeans that are relatively cheap have been joined by hyper-expensive designer jeans in the $75-250 range and above (with many over $75 and $130-150 a common price range). No article of clothing has the same place in the culture. (Trebay 2004, 3C). Main-stream jeans (Levi's, Lee) have been termed "iconic jeans" which strongly suggests a cultural icon status. (Trebay 2004, 3C).

A second cultural icon may be that of the personal computer. Clunky, room and even building-sized computers of the World War II era have evolved into frequently tiny objects with ever more power. Simple computers became networks and with the internet a vast interconnected information system spanning the globe. 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 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, foci of the time. There are obviously many materials in use from traditional iron to plastics. In the post-World War II era 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.

One synthetic polymer of significance in this time has been lycra spandex (also known as elastophane). Lycra was invented by Duport in 1959. (Reisch. CENEAR). It was originally employed for foundation garments but it spread to athletic clothing in the late 1960s and 1970s. Since then it has become a 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). Lycra is one product in one industry yet as it takes on a character of ubiquity it has in some sense become a cultural icon in its own right.

5B External Factors Affecting Transportation- Markings Design

5B1 Introduction for 5B & 5C

Design has several dimensions in T-M: 1) There is a historical process at work: much of the current design of markings has Victorian and Edwardian antecedents (5B2). 2) Design is affected by science and technology: materials from which T-M forms are constructed have a direct bearing on design (5B3). 3) The exigencies of the modes of transportation have a design; routeways and their physical environs have an impact on design as well (5C1 a). 4) Design is shaped by the internal requirements of T-M (5C1 b).

Other dimensions include: 5) The given characteristics of T-M are the result of the various aspects of design interwoven with the aforementioned factors. Design concepts such as minimalism and form follows function can be applied to T-M since T-M design is marked by simplicity and an utilitarian character (5C2 a). 6) Design does not exist as an isolated unit. Any object can reflect it times (e.g., social, economic, and cultural themes and values of an era). T-M is no exception even if viewed as 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).

7) These remarks are directed to T-M in a general sense. They are not directly aimed at the message systems of T-M forms. 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 source emissions are arranged (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, more elusive sense (5C3 a)-c).

References notes are substantially reduced in Chapter 5B and 5C. Many of the materials are extracted from the modal monographs of this Series which do include references. Part J, *Transportation-Markings: A Historical Survey, 1750-2000* (2002) also supplies information on the Industrial Revolution(s) and development of T-M forms.

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 complexity 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 through various means including the establishment of sea-lanes which led to the movement of ideas followed by political domination. Eventually railway systems were established in many regions often by the nationals of a few industrialized states that further broke down cultural and political differences though usually for the benefit of only a few.

Some movement 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 have had a disproportionate impact in virtually every part of the world.

It was in this changing world that modern T-M forms were developed. The designs and building of these safety aids 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. The great lights, through expansion of technology and transportation, moved outward to yet more difficult sites in home waters then to sea-lanes and coastlines around the globe.

Many of these lights were of English provenance and are quickly recognized as such (for example, the shape of the lantern house is a distinctive design that is often repeated; various designs are not greatly different.). The basic design was essentially repeated wherever the English were to be found: India, British Columbia, West Indies, Australia, South Africa. It would be simplistic to suggest, for example, that the Stevenson family and the Chance company (engineers and makers of lighthouse equipment) entirely shape Victorian lighthouse globally (other firms in Britain, France and other nations were also crafting lenses and towers). But a few English firms did imprint marine markings with an easily recognized design and silhouette.

The expansion of railway signals demonstrates a similar pattern through 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 model with 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 great varied. Both models are a cultural-technological-transportation-and-communication "mix" (or matrix) translated into a design.

A third semaphore design of some note is 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 locations 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 photograph in the files of this writer that shows a "flapper" hanging onto an early traffic signal. Somehow the two images 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 can end up listing many science and technology changes of the 19th and 20th centuries. However, it may be possible to indicate changes directly involved with T-M and their design. This review is divided into an older -- and mostly Victorian -- era, and a second period emphasizing on recent decades.

A significant characteristic of the Victorian era is the availability of iron. This is especially true of the latter phase of the Second Industrial Revolution. The development of iron production affected 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 of wood construction and though some wood buoys would continue in use there use would decline. 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 in safety aids included an increased production of glass for signal lenses coupled with an improved ability to produce glass of unvarying quality based on science-based research.

All of these changes affected design: new forms of markings required design work and new materials increased the sophistication of existing forms of markings. The greater flexibility in the designing and constructing of safety aids

would transform T-M.

A review of changes in the 20th century that have had an impact on T-M is more challenging since there has been a virtual explosion of basic and applied science and technology in the 20th century. A simple listing of changes would be prohibitive in length. The following review, though tending toward the random and eclectic, suggests some areas of changes in T-M within a design perspective.

One focus of change is the micro-processor. It has greatly affected T-M though to what degree has that change 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 messages have not greatly changed because of computers. It can be said that for the most part T-M messages and meanings have only been indirectly affected by computer technology. This refers more immediately to visual and acoustical aids. However, computer technology has a more direct role with 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 has often eclipsed visual and sound aids. Electronics has had both a major impact on the inner workings of markings and a direct impact on markings and message production and emissions. Electronic markings as well as the replacement of electro-mechanical inner workings by microprocessors have both altered the design process.

Metallurgical changes have also been of significance: steel has largely replaced iron; aluminum and stainless steel have taken on major roles in T-M. Welding has replaced rivets in metal assemblies in many cases, and in other cases structural steel and bolts have found many uses. 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. Plastics are nearly ubiquitous and superficially ephemeral objects. As a result their direct role can be easily overlooked. Often times plastics are virtually hidden since their appearance can be confused with glass, fiberglass, paint, fabrics, paper.

Plastics, in the true sense of the word, began in the early 20th century. Their use in T-M has become ever more vital. The flexibility of plastics in extrusion processes, in liquid forms, and in maleable units has made it important for the design of T-M including housings, supports, backup structures.

The available range of plastics is nearly endless. They include acrylics which has been molded into sophisticated lenses that efficiently emit messages for marine aids and have proved durable even in harsh marine climates. Cellulose acetates 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 in use across the length and breadth of T-M. The form of present and future T-M forms will be substantially affected by plastics.

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

This topic may appear to be well removed from design as such. While it may not be a direct and immediate component of design it does aid in shaping the direction and content of design. Routeways can be divided into two general forms of precise limits, and of flexible limits; specific forms of routeways manifest more nuanced differences.

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 generally 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 structured and delineated yet allow for greater variations. Intra-modal relationships are a vital element of road markings. Both interaction between modes of transportation and between routeway 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 routeways, 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 airports routeways are abstract constructs with very limited physical boundaries. At airports the direction 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 in boundaries. Channels are marked for inland waters, and charts -- though not markings in themselves -- denote routes offshore. The surrounding terrain, admittedly of a watery 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 marine forms are beacons not signals in nature).

b) Influence of T-M Internal Requirements on Design

T-Ms can be likened to a many faceted prism with each prism displaying additional prisms; some of these facets refer to design. This segment of the study has an elusive focus not easily captured. The core question is: how does the

"withinness" of a T-M form affect design?

More precisely, 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 overladened 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 and 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 so the lantern house, mechanism (clock work device, lens, burner, wicks, etc) were large and the power source (liquid or vaporized fuels) required on-going directly human attention. The creation and projection of the message was not impeded by the size of the structure, 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 structure (or at least on-site assembly), a self-contained lantern (of a traditional form of cast iron, glass panels and requiring frequent maintenance [and even daily care which could include adding of fuel, and lighting of the lantern]). Newer major marine lights may be constructed of structural steel members, often prefabricated, with a self-contained light apparatus (often of aero origins), computerized and automated, and requiring little human attention. Smaller lights often consist of pre-assembled daymarks (including large, easily-read identification numbers), prefabricated 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 newer vintage, present a different problem: they 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 affected 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 frequently 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 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 fewer 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 culture but it is also part of past markings which, in turn, were affected by their cultural matrix. This is also true of science and technology which have a past as well as a present. And science and technology have 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 forms. That safety aid affects other parts of the larger system both in the Victorian era and thereafter.

No element is lost, no factor fails to affect others 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 topped by cast iron lantern houses. The latter encompasses massive

jewel-like lense, brass clock work mechanism, oil fueled burner and ethereal wicks under the close watch of a lightkeepeer.

It would be difficult to dissect a marking and say, for example, that factor "x" with 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 consequence 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

These reflections cover a lengthly period of time, include diverse topics and focus on what is not entirely tangible and may be elusive. The central tenet of these remarks is that the T-M does not exist in a vacuum; that it is part of the cul-ture in which it is found; in some sense it is a reflection of that culture. That reflection is seen mostly through the medium of design: design of the structure that makes up a mark-ing, 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 specifically 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 age and important dimensions of those reflections have carried over into the present. The cultural currents of that 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 much of Victorian architectural and other 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 reflect mainstream attitudes. These include increased development of minimalism, of a form following function (and a variant type: form following efficient usage which is not necessarily the same), a non-permanence of structure (though not necessarily 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 graphic 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 simplicity 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. The passage, in part, reads:

> 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 virtual fusing of form and function into one dimension. They are notable examples 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, communications 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 those 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 not a musty anachronism of the past.

b) T-M: A Reflection of its Times

T-M's role as a culturally-reflective object is largely accomplished in and through design. That design may have often been design with a small "d". That is, a localized design by crafts people and engineers without formal training in design. Nonetheless, it was a bona fide design and it reflected the culture of which -- and in which -- it took place. T-M may have been peripheral to cultural processes in some respects. Yet when viewed from the perspective of semiotics and communications it constituted a core element of cultures and societies since it was a core element of transportation, communication and information systems.

T-M follows a logical and empirical path that results in designs that focuss on what was necessary to project the message with little thought given over to "style" and "fashion." And in that process T-M was influenced by cultural patterns and reflected a given culture.

Newer T-M forms more strongly exemplify minimalism and functionalism (though those terms probably were not employed in T-M design in many instances). Nonetheless, starkness, economy, boldness and a 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 lens, operating mechanism, and a housing that fits snugly about the lens and its inner mechanism, and help 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.

Older T-M forms were often of a more permanent nature and marked by a more 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 and 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. As well as fewer rivets, more welding; less complex glass assemblies and more acrylic; less electro-mechanical devices and more computers. These changes have become the hallmarks of new 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 decipher and decode; the meaning may, in fact, have become more difficult to unravel). Numbers and day-marks (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 of the larger society.

The design of T-M forms, both structures and message systems, has been undergirded by cultural characteristics that 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 also 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 in contrast to the older system of US marine aids to navigation (and no doubt other national systems) which did not fully incorporate river and harbor lights and daybeacons into the buoyage system and as a result many lights were nearly

independent agents marking a point, channel edge, etc. even if in close proximity to a system of buoys marking parts of the 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 and 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, none-theless, part of the message configuration since the "non-message" silhouette of mast and ladder in itself denotes an upcoming message even if the specific message can not be deciphered when some distance away. 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. These message 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* speaks of graphic symbols as having three forms: a) pictorial (or iconic); b) related to images; and c) abstract (or arbitrary); (the final form includes the alphanumeric. (Modley 1976, v). This schema includes three forms of graphics symbols rather than three or more forms of visual symbols. But this compiler, after a long 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 Symbols Designs

Graphic symbols 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), representa-

tions of recognized objects (e.g., bridges, railways 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, diamond, elipses, 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 runway 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 warning 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 these 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 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 si [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 denote 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 displays a perhaps curious appearance: to speak of the designing of messages 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. A quote of Paul Grillo in his *Form, Function & Design* offers a perspective on design that may support the unconventional view of design in this study: "... 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." (Grillo 1975, 15).

* * *

Chapter 5A may seem far removed from Chapter 5B/-5C. Yet they are linked: 5A provides a context for T-M especially as designed objects. The terms, design process and objects of 5A are very much the fabric of culture. That is also true of T-M in 5B/5C. Many of the designed objects are of simple, uncluttered and durable character. That suggests T-M as well.

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