RICE UNIVERSITY

STRUCTURE AND FUNCTION OF A SECONDARY LINGUISTIC CODE:
COMMUNICATION OF AIR TRAFFIC CONTROLLERS

by

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A THESIS SUBMITTED
IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF

Master of Arts

Thesis Director's signature:

Houston, Texas
May, 1976
ABSTRACT

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A vocational group in our society that uses a special language in their work was selected for a study of their language. The group consisted of air traffic controllers. This vocational group undergoes special training in connection with their work, which training provides them with knowledge and information together with a language and phraseology that enables them to clearly and concisely communicate with pilots and other controllers. The structure and function of this linguistic code was studied.

The specified purpose of the language and phraseology of air traffic control is communication in which precise understanding is primary. Since a vocational group is a group in only a limited sense, this language is based on its use in the cognitive environment of flying—an environment that contains concepts and values important in the physical environment of flying. Controllers, who are earthbound while working, must be familiar with this cognitive environment and relate to it easily.

This research was conducted over a period of several months in the Air Route Traffic Control Center in Houston, Texas. Data were obtained primarily by observing and listening to the work of controllers. By being present during the classroom instruction of controller-trainees and in the control
room while controllers were working, I was able to study the work and language of controllers in detail while it was in actual use.

It was found that elliptical syntax in the phraseology of air traffic controllers was successfully utilized to provide brief, concise communication because both controllers and pilots operate in a situation where the background of knowledge and information are shared. I also found that while the goal of understanding in communication is highly successful, it is still possible on occasion to have a difference in interpretation, indicating that understanding in communication is not easy.

A diachronic study of the language showed that, while occasional changes in the phraseology have occurred for clarification, more often changes have been in additions in procedure and phraseology owing to technological developments. The language and phraseology now contain many additional acronyms and code word. Since the added procedures mean more information must be learned and utilized, it may be that acronyms provide a means of linguistic recoding that makes possible learning and processing of more information.
ACKNOWLEDGMENTS

I wish to thank Dr. Stephen Tyler for his advice and encouragement in the preparation of this thesis, and to acknowledge the influence of his own unique background and scholarship on my own education, which helped make this work possible. I would also like to thank Dr. Edward Norbeck and Dr. Hugh Anderson who served on my examining committee, and Ms. Barbara Podratz for her frequent help and assistance.

This work could not, of course, have been possible without the cooperation of the air traffic controllers at Houston Center. They were not only generous in accepting my presence while they were working, but they patiently explained their work to me and answered my questions. While it would be difficult to acknowledge individually the many controllers who have contributed to this work, I do wish to thank Mr. Jesse Berwick and Mr. Tom Clements for helping me to get started.

Finally, I would like to thank my family for their understanding patience and kindness during the times I was occupied with my work. My husband, Alex, on innumerable occasions advised, helped, encouraged and sympathized, all of which helped in the completion of this thesis.
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I. INTRODUCTION

Highly industrialized societies are complex organizations of overlapping and cross-cutting groups, which can be variously considered in terms of ethnicity, income, religion, kin, common-interest and vocational. Individuals may be members of more than one group, and usually are members of several. While certain criteria, such as income or religion, may limit choices in some cases, the membership possibilities available for any individual are great, and it is not usual for the same combination of individuals to be found in more than one group.

Since our society consists of so many different groups with special interests and needs, it is not surprising that our language contains many specialized vocabularies and/or "languages" expressing these various purposes. Specialized languages not only aid understanding and communication within the group, they promote group solidarity.
Such languages are often understandable to outsiders only after segments of the specialized vocabulary find their way into the general language pool. Both the argot of the jazz musician and the "inputs and outputs" of computer technology have uses now that are more extensive than their original purpose. To be "hip" means not necessarily to be familiar with current jazz ideas, but with any ideas shared by a particular group; "send" likewise can be found in more situations than to excite the listener with a jazz performance. The term "input" is used in many areas to identify any material on which some results are based.

The existence of specialized languages implies that variant linguistic forms develop in order to facilitate the expression of ideas and values important to the individuals of some group. Whether such linguistic variations are consciously or unconsciously developed, the end result is the same—variations are used to aid in understanding and communication, to index group separateness, and as a badge of group membership. In all instances, the same ideas, values, and concepts could be expressed in other ways, even in everyday language, but they are not, and it is this fact that is important.

Professionals in many areas speak to colleagues in special language, while using "lay" language to communicate outside of their field. Thus, doctors use medical terms
with other doctors, but give nonmedical descriptions to their patients, and the language of the law can be understood by lawyers—if at all. The use of special vocabularies or languages is not confined to occupational groups but occurs among hobbyists, sports fans, and other common-interest groups. One cannot be a stamp collector and not know the difference between "perf" (perforate) and "imperf" (unperforated).

For this study, I focus on the language used by air traffic controllers. This special language, shared by all controllers (and pilots to some extent) was developed within the last thirty years in order to facilitate communication in the special area of flying. Since the primary aim of air traffic control language is to ensure safety of air traffic through the orderly and expeditious control of such traffic, study of this language provides an opportunity to see how this is accomplished. What factors have to be taken into account to promote complete understanding at all times, and how are these implemented? What are the problems in air traffic control communication, and how are they resolved? While the basic function of the language and its reason for existence is explicit, I intended to investigate particular development of language forms, reasons for such development, and implications of these for language develop-
ment in general.

In attempting to define air traffic controllers as a group with a special language, I considered the group as a possible "subculture." This term seems to have some flexibility. Spradley writes that our society is "multi-cultural" and also that it is "pluralistic" (1970:4). In his ethnography on urban nomads, he uses the word "culture" when he refers to the "knowledge these men have acquired and use to organize their behavior." He continues that their "culture is the set of rules they employ, the characteristic ways in which they categorize, code, and define their own experience" (1970:7).

In a more recent ethnography of drug addicts, Agar defines the "nature of ethnography" as a decoding operation. After an ethnographer observes that there is intercommunication within a group which is not understandable to an outsider, he "asks what knowledge is necessary to interpret correctly the verbal and nonverbal messages" (1973:11). Both Spradley and Agar relied heavily on the use of language within their particular group. The behavior and interactions of the individuals in these groups were described in terms of the vocabularies and language as used by the individuals themselves, which use was recorded by the ethnographer.
The subcultures of addicts and urban nomads are more easily identified than are most groups in our society, for these groups have lives and activities apart from the mainstream of our society. This is realized both by individuals within the groups and outside the groups. In fact, it would probably be acknowledged that the majority of individuals in our society are not only aware of the special interests and activities of urban nomads and addicts, but consider their activities undesirable, immoral, and/or illegal.

Language and communication and the relation of these to social interaction are the subject of many studies in the area of sociolinguistics. These studies vary in their scope, methods, aims and results, but they are principally concerned with investigating social interaction as it is revealed by language. They include studies of specific interaction between individuals or groups. Studies may focus on choice of particular terms of reference or address in different interactions (Tyler 1972:251, Ervin-Tripp 1972:213), or may investigate the relation of language use to topic in bilingual or multilingual groups (Blom and Gumperz 1972:407, Fishman 1972:435).

Hymes writes about sociolinguistics:

Sociolinguistic systems may be treated at the level of national states, and indeed, of an
emerging world society. My concern here is with the level of individual communities and groups. The interaction of language with social life is viewed first of all a matter of human action, based on a knowledge, sometimes conscious, often unconscious, that enables persons to use language. Speech events and larger systems indeed have properties not reducible to those of the speaking competence of persons. Such competence, however, underlies communicative conduct, not only within communities but also in encounters between them. The speaking competence of persons may be seen as entering into a series of systems of encounter at levels of different scope. (1972:53).

Hymes also writes that the "essential thing is that the object of description be an integral social unit" (1972:55), and mentions many possible categories of investigation. He includes speech community, situation, event, act, styles, ways of speaking and components of speech. Components can be grouped together as message form, content, setting, scene, speaker or sender, purposes-outcomes, purposes-goals, channels and forms of speech.

As a specific language for a special purpose, the language of air traffic controllers was developed to coordinate and control air traffic so that it could move safely along special routes and through specified areas. This language is used between controllers within the various control facilities; it is used between controllers communicating between control facilities, and it is used to communicate with pilots. My interest in this study was not only in communication, its implications, problems and possibilities, but
also in the structure of the language itself, both synchronically and diachronically.

The category of occupational groups and the use of special languages has been noted by Ervin-Tripp; she writes:

.. Language changes related to work arise for three reasons. One is that any activity brings with it objects, concepts, and values which are talked about by specialists in that activity, and indeed may be known only to them. Another is that whatever solidarity an interacting work group may achieve, or whatever identification a reference group (e.g. psychologists or transformational linguists) may stimulate, it can be alluded to by selection of appropriate alternatives in speaking or writing. Many instances of abbreviations in factories, or of work-group slang, or of technical terminology synonymous with colloquial vocabulary, must have this second feature. Further, the particular communicative conditions might give rise to some features—signal tower communication, headline style, the special syntax of short-order restaurant speech. While the slang and lexical features of restaurant speech can be found in kitchens, fast unambiguous oral communication needed between waiter and cook alone may lie behind the special syntax. .. Virtually all registers, including that of social-science writing, have syntactic as well as lexical features. The details of the co-occurrence rules for such styles remain to be studied (1972:239).

The unique occupation of air traffic controllers requires a special knowledge and necessitates the use of a special language to go with this knowledge. Controllers think and work in a physical and cognitive environment that is generally unlike any other in our society. This
work is high specialized, and takes an average of four years to learn. The training and knowledge is useful for only this occupation, but the job could not be performed by anyone without the training.

The cognitive environment of an air traffic controller is one in which certain concepts and values take on special meanings. It is an environment in which time and space can often be equated, and in which what may be considered routine or ordinary in another instance could have important consequences in the environment of flying. Any uncertainty, hesitation in a decision, miscalculation or misjudgment may have implications concerning flying that go far beyond what implications and results would be in another situation. The environment of flying is one in which changes in wind current, cloud level, or change in temperature have a different meaning and relationship than in everyday life. It is an environment in which optimum physical health is important.

In this environment a controller must be prepared for the unexpected, ready for any exigency. He is aware of the fact that at any moment his job may require that he coordinate and control aircraft worth millions of dollars, which also may involve hundreds of lives.

When an air traffic controller is engaged in his work, he must have certain cognitive models that he uses in
the interpretation of events and occurrences in this environment. What is the structure of this language that has been developed for special use of a special group, and how does the language function efficiently?

Just as distance in astronomy is measured in units of time in a given time, i.e., light year (distance light travels in one year), flying in our atmosphere cognitively relates space and time—often the two are interchangeable. Functioning as a pilot or as a controller in such an environment must take this into consideration, and the language that is used will reflect the different aims, goals, problems and situations that are unique and important in this environment. The present occupational environment of air traffic controllers is indicative of cognitive changes which are necessary in the present for air travel and in the future for life in space. Concepts and values in any situation, far from being absolute, depend on references, and references depend on a context or environment. A cognitive environment may or may not be at one with a physical environment at any particular time. Pilots when flying are physically and cognitively operating in the same environment; controllers are terrestrially bound physically, but while working, they must be aware of the special concepts and values important in flying.

In our culture, it is possible for an individual to
make frequent changes in his cognitive environment. Such changes would alter the way he thinks and talks about concepts and values at different times. In the case of air traffic controllers, their ideas about time, speed, weather, and space will generally be different when they are working and when they are not. Words and language may take on different meanings in different cognitive environments. By crossing boundaries and applying concepts from one environment to another, usage may be metaphoric. A pilot who is literally "flying high" in a plane is not doing the same thing when he is "flying high" at a party.

Owing to the nature, necessities, and aims of their work, the language of air traffic controllers must be brief, accurate, and precise. It must not be ambiguous and should be clearly communicated by radio. The language and official phraseology have been developed with these points in mind; air traffic control procedures stress understanding at all times.

The language of air traffic controllers presents an excellent opportunity to study the systematic development and use of a language designed primarily for communication. It is a language that is officially recorded, comprehensively studied during the training period, and it is continually being updated if and when any problem in understanding or communication is indicated.
The phraseology must not only be easily understood; it must be brief. While a controller may not always be busy, he must be prepared at all times to work at top efficiency and speed if the occasion arises; urgent situations may occur without warning. My study of the phraseology includes examination of its structure, form and style, the characteristics of the syntax and of the choice of lexemes, to determine how all these reflect the special concepts, values and needs of controller communication. Choices of lexemes in the phraseology must recognize the importance not only of meaning but also of sounds. Since the radio and telephone are used almost exclusively in this communication, the aural qualities of lexemes must be considered together with meaning and syntax. They must be clear and not easily confused.

One of the reasons sometimes given for lack of understanding between communicating individuals or groups, is that both sides "were not talking about the same thing." Understanding in communication in some segment of our culture may often only have a subjective reality not necessarily shared by all involved in the communication. Studying the phraseology and language of air traffic controllers as used in their work can reveal much about this aspect of communication and understanding. Since controllers and pilots of aircraft operate in the same cognitive environment, the
knowledge of the language and the background for the language is the same. Pilots are under the same Federal Aviation Administration (FAA) rules and regulations that govern the work of controllers, and they must learn the phraseology necessary to enable them to communicate with controllers. Given optimum conditions for understanding, how well do they understand each other?

It can be assumed that pilots and controllers desire full understanding at all times. Misunderstandings would benefit no one, and consequences could range from emotional stress and trauma to injury or fatality. Efforts are made to keep this from happening. If an "incident" does occur, there is an investigation, and if it is determined that the fault is due to some lack in communication between a controller and a pilot, attempts are made to clarify the language and phraseology so that such a misunderstanding will not occur again. The fact that a misunderstanding will be specifically recognized as such offers an opportunity to investigate communication and understanding in a way that is not possible in most other segments of our culture.
II. AVIATION AND THE FAA

The growth in the size and complexity of aviation is often not appreciated. While most people realize that there have been many changes in aircraft since the first flight of the Wright brothers traveled 120 feet and lasted 12 seconds in December, 1903, the scope of developments is phenomenal. Today aircraft are built whose wing span is greater than the distance of that first flight. There is no earthbound means of transportation that has undergone so many changes with nearly the same magnitude of increases in speed.

The speed of the plane of Orville and Wilbur Wright was about 6.8 miles per hour. At the end of World War I, just 15 years later, planes were able to fly about 120 miles per hour, and by the early 1930's, planes were winning races at speeds of 300 miles per hour. During this period, there was much experimentation in many directions,
all of which contributed in one way or another to the spectacular development of aircraft (Taylor 1972:71).

Some pilots wanted to fly higher and faster than had ever been done before, and distance and speed records were continually challenged. There was also development of aircraft for specialized uses. The first four-engine clipper-type aircraft was built in 1931, the first pressurized cabin developed in 1936. Airline carrier service was increasing all the time, and by 1936 the first Douglas DC-3 sleeper plane entered carrier service. Developments were also under way in navigational aids. An automatic direction finder for aircraft was first tested in 1934, and the absolute altimeter was developed in 1938 (World Book Encyclopedia 1958:142-3).

During and after the 1930's, the growth of aviation accelerated, although for many years the gasoline engine was the only type used for aircraft. This engine imposed limits on the maximum speed that could be achieved—up to about 500 miles per hour. Development of the turboprop engine made speeds of over 550 miles per hour possible, and the turbojet engine boosted speed limits to about 1150 miles per hour. Eventually, even more powerful rocket engines were developed. The first supersonic flight (faster than 760 mph) was made in 1947 in a rocket-powered experimental plane. Only six years later this speed was doubled when an aircraft went twice the

All through the history of aviation, the development of aircraft has shown much variation and ingenuity. There are planes for transportation, private and public carrier, and planes for crop dusting, patrol, photography and acrobatics.

Aircraft used for transportation come in many types and varieties. There are large planes with two, three and four engines; the engines may be propeller-driven, turbo-prop engines or jet engines, and there are small planes powered by one or two engines. There are also planes especially equipped to land on snow or water, and still others like the helicopter or gyroplane developed for vertical takeoff and landing.

All of these aircraft have many uses. Among planes used for transportation, there are those owned by individuals and by corporations. Public carriers may be small, local taxi services, regional carriers, or national or international lines. The size and capabilities of an aircraft are influencing factors in determining its use, and this use in turn is a factor in determining its performance.

Developments of military aircraft have occasionally paralleled civilian use, but the special needs of the various branches of the military have resulted in special adaptations. Thus, there are not only the usual carrier and cargo
planes, but also bombers, fighters and reconnaissance aircraft.

During the early years of flying, little thought was given to air traffic as a serious problem. Then, a pilot had few instruments and generally flew "by the seat of the pants." A cautious pilot flew only when weather and visibility were good, and there simply were not many planes around anyway. A major concern was to get the plane off the ground, keep it up as long as practicable, and land without mishap. A good landing was thought to be "one you can walk away from."

In 1926, the Federal government, through passage of the Air Commerce Act, made it necessary for pilots and aircraft to be certified to fly. From that time on, aviation has been controlled by a regulatory agency of the Federal government.

The aviation industry grew and expanded through the 1930's. Developments in aircraft, increased speeds, more interest in travel by plane, led to an increased number of aircraft and made flying safety of more and more concern. In 1938, the independent Civil Aeronautics Authority was created, and two years later, a reorganization gave economic regulatory and rule-making responsibilities to a Civil Aeronautics Board, while operating the airways was assigned to the newly designated Civil Aeronautics Administration.
There was no change in this basic arrangement until the Federal Aviation Agency (FAA) was created in December, 1958, after passage of the Federal Aviation Act. Later, in 1967, the Federal Aviation Administration became part of the Department of Transportation. (Federal Aviation Administration 1971:1-2).

The FAA's responsibilities in aviation are all-encompassing. They include everything from the inspection and certification of plans for any proposed aircraft through the inspection and certification of the aircraft when it is completed at the factory. The FAA also sets all the rules and regulations that make it possible to fly that aircraft.

Navigational aids used in aircraft must also be approved by the FAA, and the FAA specifies requirements for their use. Certain kinds of navigational aids must be used under certain conditions, while use may be optional at other times. (For instance, to land at certain terminal control areas, a plane must have particular equipment on board.) Regulations of the FAA cover mechanics who maintain the aircraft, pilots who fly the aircraft, and flight instructors who train the pilots. Requirements that are necessary to obtain licenses for these specialties are specified by the FAA, and the FAA provides and administers the tests for the license itself. The FAA regulations are also specific in regard to the physical requirements that are necessary for
these licenses, and states how often examinations must be made to insure that these requirements are maintained.

The FAA certifies who may fly, and specifies the restrictions or limitations. There are many categories of license, VFR (visual flight rules), IFR (instrument flight rules), private pilot, commercial license, twin-engine aircraft, jet aircraft, to name a few. Obtaining a license for any of these categories is only possible after an appropriate period of instruction and learning and subsequent testing.

In the event of any accident or mishap connected in any way with flying, the FAA takes part in any investigation along with representatives of the National Transportation Safety Board.

The airspace used for flying is also under the jurisdiction of the FAA. Within the National Airspace System (NAS), the amount of special controlled or restricted airspace has increased through the years, along with the rules and regulations that specify its use.

Controlled airspace may be designated as continental control area, terminal control area, control area, transition area and control zone. These designations give different meanings to very specific areas of space. All of these terms are listed under "Definitions" in the Air Traffic Control manual.
The continental control area generally takes in the airspace of the 48 states and Alaska above 14,500 feet MSL (mean sea level), but does not include the space from the ground up to 1,500 feet, or prohibited or restricted areas, except for military climb corridors that are restricted and certain restricted areas listed in a particular section of the Federal Aviation Regulations.

Control zone refers to space beginning at the earth's surface up to the base of the continental control area. Such an area is usually circular with a radius of five statute miles; it may include one or more airports. The circular area has extensions, if necessary, for instrument approach and departure paths.

A terminal control area contains controlled airspace which extends from the surface or higher to specified altitudes; Federal Aviation Regulations set forth operating rules for aircraft within this space, and specify pilot and equipment requirements. A transition area includes airspace which extends upward from 700 feet or more when it is designated in conjunction with an airport having an approved instrument approach procedure prescribed for it; when space designated in conjunction with airway route structures or segments is included, it begins at 1,200 feet. These are only a few characteristics of some specifically defined areas, which have particular meaning in air traffic control.

In the National Airspace System, air traffic control
is defined as a service which is provided for the "safe, orderly, and expeditious flow of air traffic." In an area of positive control (PCA), all traffic is subject to control. When space is classified as "restricted" it means that while there are times the area will have special regulations with regard to general traffic, there are other times such an area may have no restriction at all.

The National Airspace System contains airways and jetways for the movement of traffic; these are the equivalent of freeways for automobile traffic. It is along these airways and jetways that air traffic is coordinated and controlled. Everything that concerns flying in United States airspace is part of the National Airspace System. This includes all the rules, regulations, technical information and the organization of the FAA. There is also coordination of civil and military air traffic.

Air traffic control as part of this system includes facilities that are used as aids to navigation or communication (e.g. radio or other electronic communication), as well as apparatus or equipment for weather information or signalling. It also includes any land with its buildings or facilities that may be used for landing or takeoff of aircraft. An air traffic control specialist (i.e. controller) is a "duly authorized person providing air traffic control service" in airport towers, approach control facilities and enroute air
traffic control centers.

These facilities are numerous and are located in all the states and territories of the United States. There are 25 Air Route Traffic Control Centers (21 in the continental United States); there are also about 400 airport control towers and over 300 Flight Service Stations (Air Traffic Control, Department of Transportation). A Flight Service Station (FSS) provides information to pilots about weather, present and forecast, for the flight route and terminal area, winds aloft, special notices of severe weather, or radio navigation equipment failure.

Flight Service receives IFR flight plans and transmits them to the Air Route Traffic Control Center (ARTCC) for that area, and Flight Service also opens and closes VFR flight plans.

Controllers located in towers at airports direct aircraft movement arriving at and departing from the airport, and control traffic on runways and taxi strips. In addition, about 150 of the 400 or so FAA control towers provide IFR traffic approaching and departing that airport with radar service. Enroute air traffic control centers then provide additional traffic control for IFR aircraft. The network within the air navigation system contains about 250 long-range and terminal radar systems, more than 1000 radio navigation aids and instrument landing systems totalling nearly
An enroute center uses long-range radar and remote air-ground communications sites; besides a staff of controllers, it has its own engineers and technicians. Air Route Traffic Control Centers use a computer-based semi-automated air traffic control system through the contiguous 48 states and at all major terminal facilities.

The procedures and regulations regarding any particular aircraft depend somewhat on its type, its equipment, the reason for its flight and location of its operation. In addition, a pilot is not simply licensed to fly—he must obtain a license for a particular kind of flying. A pilot would need certification for each type of aircraft he wishes to fly, whether it is a single-engine plane, twin-engine, multi-engine or jet. He might have a VFR license or one which qualifies him to fly IFR. To carry passengers for hire, he must have a commercial license.

Flying which involves the least number of special procedures, is flying in good weather in areas without special controls or restrictions—flying according to visual flight rules. A pilot may fly VFR in a number of situations. He could fly from a small uncontrolled airport, through uncontrolled airspace to another airport without a control tower. In such a flight a pilot may not talk to any air traffic controller (although he might get weather
information from a Flight Service Station). In another instance, a pilot may fly VFR from an airport which has a control tower to another airport with a control tower. In this case, the pilot will communicate with controllers at each tower. At larger airports, the pilot would communicate with controllers in the tower and also controllers in departure or approach control. He can still fly VFR some of the time if the weather is good and the airspace he flies through is available for this kind of flight.

There are times, however, when a pilot either prefers or is required to fly according to instrument flight rules, or IFR. Certain designated terminal control areas and certain weather conditions make IFR flying necessary; air carriers are required to fly IFR at all times. When a pilot flies IFR, he is in contact with an air traffic controller; he has the benefit of being advised of traffic enroute, weather conditions, and any other information that the controller has available. To fly IFR a pilot must have more hours of instruction and further certification by the FAA than one who has a VFR license. Certain equipment in the aircraft is also necessary for IFR flights.

Although any pilot has some contact with air traffic controllers, the amount of such communication will depend on the kind of flying the pilot does most often. A pilot of a small single-engine propeller plane operating most often
in an isolated area in and out of small uncontrolled air-
ports will seldom talk to a controller. Such a pilot may be
contrasted with the pilot of an air carrier, who must talk
to controllers all along his route of flight. Military
traffic is coordinated with other air traffic, and they
communicate with controllers for a large part of their
flying—although there are times that they take part in
VFR operations.

Air traffic controllers must deal with many kinds
of traffic. They must learn about types of aircraft, air
speeds, navigational equipment, and weather. They learn
rules for the separation and coordination of air traffic,
and must communicate these to the pilot. This is done as
clearly, concisely and briefly as possible in the official
phraseology developed for this purpose. The phraseology
was developed to be the best method of communication in
situations where the communication is by radio, and where
time is of great importance. Understanding easily and quickly
is stressed; thus, the phraseology must consider both syntax
and lexemes in the arrangement and formation. Lexemes are
chosen for clarity in meaning and in sound. It is, however,
most important to realize that the phraseology is based on
expected knowledge shared by both pilots and controllers.
All of these factors must be considered in an analysis of
the language.
III. CONTROLLERS - THE PHYSICAL ENVIRONMENT

Airspace of the United States contains many areas and locations with numerous designations, some of which are coordinated with locations on the ground. Boundaries of areas and locations are outlined on maps and can be found by the use of navigational equipment. Within this airspace there are more than 280,000 miles of Federal airways, which can be considered as part of two systems. The low altitude airway system begins at 1200 feet and ends just under 18,000 feet, and the high altitude airway (jetway) system begins at 18,000 feet and ends at 45,000 feet. Space above 45,000 feet is assigned on a random routing basis. Traffic along these airways and jetways is coordinated and controlled by air traffic controllers who work in FAA facilities on the ground and furnish separation and coordination information to pilots they "see" on radar screens.

Controllers in a tower are the only controllers who
have visual contact with an immediate segment of flying. They see the runways and taxiways, and they see planes landing and departing from them. However, all other controllers are too far away from the traffic they control to see it visually. (Even the tower does not see all the traffic it controls. Once traffic leaves the vicinity of the tower, it is not possible to follow it visually. If the weather is not very clear, the tower will see even less traffic.) However, no matter how good the weather is, other controllers either in approach (departure) control or in an enroute facility, never see traffic visually. Their communication is by radio or navigational aids only. Controllers can identify aircraft by means of lines on a screen, which they see in one sense, but they do not actually "see" the aircraft. Controllers can also see some weather on a radar screen, but most information on weather is made available from information received from various areas and processed by the computer.

Air traffic controllers physically work in a control room that is dark and windowless. While the darkened interior of a control room facilitates the use of the radar that is used by the controllers, such a physical setting (free from the distraction of anything that is not related to their work) may in some way help relate the controller cognitively more completely with what is the physical and cognitive environment of the pilot. Since the controller may work as far
away from the area of his specialty as 400 miles, there may be vast differences between the two areas in weather conditions. Looking out on a calm, warm, sunny day, may be of some cognitive disadvantage when a controller is vectoring traffic through airspace in an area where the weather may be stormy, windy and cold. In the darkened control room with its illuminated radar screens, and only sufficient light to read or record information pertaining to aircraft movement when needed, the atmosphere generally facilitates dealing with the work at hand---that of promoting "the safe, orderly and expeditious flow of air traffic."

At the Houston Center, a controller may be assigned to a sector which is responsible for air traffic around Laredo, Texas; Mobile, Alabama; or Picayune, Mississippi. Whatever sector he may be working, he is concerned with everything that might affect air traffic there. Each Center in the National Airspace System is geographically divided into specialties; there are five in Houston Center. These specialties are responsible for air traffic in the airspace over Ft. Stockton, Texas, to Mobile, Alabama. West of Houston Center is Albuquerque Center, North is Ft. Worth Center; Atlanta Center is to the east, and Jacksonville Center is southeast. Each specialty is further divided into sectors, and a controller must learn about each sector within his specialty. At any particular moment, the controller works
traffic in a particular sector. As an aircraft moves through that sector in any direction, the aircraft must be coordinated with the next sector in that Center, or with another Center. It is then "handed-off" to the next controller.

Since flying takes place at any hour of the day, the work of air traffic control must go on twenty-four hours a day, seven days a week, 365 days a year. There are no days during which this service is not provided. As a result controllers work shifts. The hours that are worked on any particular day by a particular controller fall into an overall schedule that is followed by all controllers. Each controller works five days in a row and has two days off. However, a controller's "day's off" change every eight weeks. The days that a controller works depend on the crew to which he is assigned. When the schedule of the crew changes, the hours of those on the crew change also.

Controllers have a "first" day of work and a "last" day, but these are seldom the traditional Monday and Friday. On their five successive days, the hours they work are part of a definite sequence. The first day's hours are 4 p.m. to midnight, next 2 p.m. to 10 p.m. The third day is noon to 8 p.m., then 8 a.m. to 4 p.m. The last or fifth day may be a midnight to 8 a.m. shift or a 7 a.m. to 3 p.m. They are essentially on duty during their whole working day; leaving the building may be done only by official leave, and there
are no scheduled coffee breaks or lunch breaks. Due to the nature of flying, and the possibility of unexpected events, controllers take such breaks when the work load permits, and not because they were scheduled ahead of time.

A controller must not only know his job, but he must be in good physical health. He is not accepted for training unless his medical condition qualifies him, and he must remain in good health to continue working. To check this, a thorough physical examination is given to each controller once a year by a medical doctor located at the Houston Center. If there are changes in his health that would medically disqualify him for his demanding job, he cannot continue working. It is important to realize that what may be considered adequate health for some other job may not be adequate for a controller.

In flying, necessary action must be taken as the need arises. While much of the work is routine to some extent, a controller must be prepared for the unexpected. There is no way to be certain what might occur at any moment—there may be increased traffic or some kind of emergency. Controllers cannot postpone their work, or even slow the pace at which they must work. If their work load increases, they must work more efficiently and more quickly. The work has to be done when needed, and a controller has to be able to deal with whatever arises. Psychologically, mentally and emotionally there are many pressures on air traffic controllers, and they are aware of them.
A certified controller is one who has successfully completed the period of instruction and learning and is qualified to do all aspects of the work in his specialty. Other than this, the backgrounds and interests of controllers are varied. A controller may be male or female and from any ethnic or racial group. What they have in common is the ability to learn what is necessary for a controller to know and to be able to apply this in a working situation. They must be able to understand the background of flying and its concepts and values, understand them, and utilize them when they use the language and phraseology to do their work. They could not succeed if they did not possess these. They must be prepared for the unexpected, and must be able to make correct decisions under stress when necessary. Quick reactions are important, and they must be made with a certain amount of confidence.

Many of these qualities are similar to what is desirable for a pilot also. A pilot must also be able to make unhesitating decisions and must be prepared for anything. However, a pilot is primarily concerned with the particular performance of his own aircraft in any situation. The emphasis for a controller, on the other hand, would generally be with more than one aircraft and their relationship to each other in the traffic under his control.

The rules for survival in the environment of flying are real and necessary for those who must operate in it,
and thus must be known by pilots and controllers alike. Flying can be unpredictable. Safety depends on many factors—efficient operating of instrument, aircraft in working order, reasonable weather conditions and the correct decisions made by human beings. Fatigue, lack of oxygen could be far more serious than in an earthbound situation. Just as controllers must be examined regularly, pilots must pass regular health examinations given by FAA approved medical doctors.

Since what each group learns is determined by the FAA, which certifies the course of instruction for both pilots and controllers and then administers whatever tests are necessary for licensing, this helps to provide a cognitive environment in which each group has the same background for understanding.
That there is a cognitive understanding and relationship with flying is indicated by verbal clues among controllers. Controllers "come on board" (begin work); they are also "checked-out" or have "check-rides" (examinations of their work by supervisory personnel). Of significant interest is the expression used by a controller to describe his work: "hours of boredom with moments of stark terror." Sometime later, when I repeated this to a pilot, he told me that pilots have a similar way of describing flying.

Since a controller is not concerned with only one aircraft, he must learn about many types and kinds. He must also learn about weather--temperature, wind, rain, clouds, hail, and how these might affect flying and subsequently affect traffic control. He must learn about the use of navigational aids and what to do when these aids do not work. For all of this, rules and regulations must be learned that have to do with separation of aircraft, vectoring
altitude assignment, longitudinal separation, lateral separation, route assignment, and many other procedures. There are nonradar procedures, and procedures using radar. A controller, while working, must continually take into account such things as the type of aircraft he is controlling, its capability (some planes can fly faster than others, some can go higher, turn faster, etc.), and the capability of the pilot. Controllers are even aware of the various policies of the air carriers and know which of two carriers is more apt to climb or descend faster in any flight. These are all important when making decisions in air traffic control.

Depending on the facility, there is some difference in learning procedures. Controllers at airports must learn rules with regard to traffic movement and signals, airport conditions, runway use, taxi and departure procedures, airport lighting, runway visibility spacing and sequencing, departure and arrival separation, and rules for special aircraft, such as helicopters.

Other special procedures that might be required for a controller could include those for parachute jumping, procedures regarding aircraft carrying dangerous materials, jettisoning of external stores, and special military operations. There are still other rules concerning emergency assistance and emergencies in general.

In all of this, there is coordination of knowledge and
of procedures between controller and pilot. A controller is the link between the pilot in the aircraft and his safe movement through space, from his ground departure until his ground arrival. The controller must accomplish his work by thinking and working in a cognitive environment that is based on certain ideals, values, expectations, possibilities and probabilities that are important and necessary in flying. His decisions, actions, preferences, choices must be made with knowledge of and on the basis of events, ideals and concepts in this cognitive environment. Anything else could be disaster. He must not only understand the pilot's situation and needs, but to some extent anticipate them. His knowledge and understanding of any situation must then result in a decision which must be communicated to the pilot and to any other controller who might be concerned.

When a controller is assigned to a specialty, his period of training includes learning not only about aircraft, weather, navigational aids, and the rules and procedures about air traffic in general, but he must commit to memory any important fact or feature that has to do with flying in his specialty. He possesses a cognitive map of all the sectors of his specialty.

The value of a mental map and the ability to use one was described by Mark Twain when he wrote about his experiences in learning to be a pilot of a boat on the Mississippi River.
over a hundred years ago. He wrote ". . you only learn the shape of the river; and you learn it with such absolute certainty that you can always steer by the shape that's in your head, and never mind the one that's before your eyes" (65). One reason it was necessary to memorize the shape was for navigation at night, especially on a pitch-dark night:

. . . the river is a very different shape on a pitch-dark night from what it is on a starlight night. All shores seem to be straight lines, then, and mighty dim ones, too; and you'd run them for straight lines, only you know better. You boldly drive your boat right into what seems to be a solid, straight wall (you knowing very well that in reality there is a curve there), and that wall falls back and makes way for you (65).

Twain sums up his period of learning:

When I had learned the name and position of every visible feature of the river; when I had so mastered its shape that I could shut my eyes and trace it from St. Louis to New Orleans; when I had learned to read the fact of the water as one could cull the news from the morning paper; and finally, when I had trained my dull memory to treasure up an endless array of soundings and crossing-marks, and keep fast hold of them, I judged that my education was complete. . (82).

A controller learns geographic areas in his specialty that would aid him in air traffic control. He learns all the airports in his area, where they are located, whether they are controlled or not, and he learns what their facilities are. He learns about special rules concerning the airspace throughout his specialty. He knows the control zones, and areas of positive control. He learns the rules regarding
areas that have restrictions. He also must know applicable rules concerning military traffic. A controller learns the location of all the airways and commits them to memory, along with any restrictions that might apply to them. The position of all the reference points or "fixes" in his specialty are important also. In controlling traffic, fixes are used as locations at which coordination may take place. A pilot might identify his position as being a certain distance from a particular fix. A controller, in turn, could use such a location as a reference point at which instructions or directions are given or changed. Such fixes are also used in published procedures for special arrival or departure instructions. Fixes are identified when equipment on the ground is coordinated with equipment in the aircraft so that such identification can take place.

Location of such ground equipment may be near an airport, outside a small town, or near some prominent landmark (such as a university). Having the location of these known cognitively means that a controller has a general map of the area in his mind. This fact can provide an interesting experience for a controller. One controller told me that his assigned specialty was an area he had never visited. When he did visit it one day, he not only knew the names of many locations and landmarks, but he knew where they were in relation to each other, and how far away they were and in what direction.
Besides learning the position of airways and geographic positions along these airways, controllers must become familiar with the special requirements that are due to the variation in the kind of traffic that is generally found within a particular specialty. Such knowledge would help in traffic control.

A controller who works in the High Altitude Specialty controls and coordinates traffic of high-speed jet aircraft, including large carriers and military aircraft. Traffic at altitudes of 24,000 feet and above travel along jetways. Aircraft traveling at high altitudes are fast, high performance aircraft; the pilots are experienced and know procedures and phraseology well. The aircraft contain many navigational aids. Since no traffic is slow moving in this specialty, however, great care must be exercised at all times to maintain proper separation. There are seldom opportunities for a change in decision by a controller. There are also special procedures to be learned, such as refueling in midair at these high altitudes, which mean additional responsibility for the controller.

A controller working in a specialty controlling traffic below 24,000 feet must learn the areas of special control and restriction within his specialty, as well as altitudes that must be applied. There would be more variety in types of aircraft, including both jet aircraft and
slower general aviation aircraft. In such a specialty, a controller would make decisions which depend on the kind of traffic he has along the airways in his control at any moment. A particular specialty might also include regular operation of military aircraft; these could have special coded procedures which would have to be learned by the controller. They would also use restricted areas at certain times, which would have special rules with regard to other traffic. Whatever the type of aircraft or situations that arise in air traffic control, there are certain concepts and values that are used as a basis for decisions.

Among these concepts and values, time, its implications and interpretations may be one of the more important. When a pilot plans a flight, he plans it in segments of time, not distance. A pilot who intends to fly IFR must make out a flight plan prior to his departure. In filling this out, he lists his point of departure and time of departure. He then records his destination along with the time it will take him to get there in hours and minutes. He also notes the amount of fuel he has on board in terms of hours and minutes. A plane does not have an odometer—it has distance indicated by the recorded number of hours the aircraft has flown. If a pilot is told to call a certain frequency in about seventy miles, he will convert this distance into time for his aircraft.
It is important for a pilot to be aware of time and distance at all times, because if he has a headwind and it takes him longer to reach his destination, his estimate of the expected distance to be covered in that flight would have to be recalculated. He may even have to change his destination. The time limit for fuel also affects destination if extra flying is necessary to get around bad weather. On the other hand, a tailwind will enable the pilot to cover a distance in a shorter time, thus enabling him to use less fuel for a particular distance. In a flight plan, alternate airport destinations must be stated in case of exigency.

A controller must be aware of all this, and must realize also that for him time has its own special features and restrictions. A controller's concern is with the orderly flow of all traffic under his control. The only constant for a controller is the goal of his work. How he accomplishes this depends on the situation at hand. The various rules for separation of traffic are clear, but the controller still has to fit what is necessary for him to accomplish into the time at hand. He must be aware of what time and space and distance mean for any particular pilot and aircraft in his jurisdiction, and he must use this knowledge in his traffic control.

The training of a controller is a carefully planned program, taking an average of four years. (Training may
take as little as three and one-half years, or as many as five years, depending on the background of the trainee.) In earlier years, a controller learned simply by doing the work; today, however, training is more complicated and includes both classroom work and on-the-job work in a carefully coordinated program. Learning the phraseology is included in every step of the training.* Radar gradually became a part of air traffic control through the 1950's, although the handbook issued in 1957 did not yet have a section on radar procedures. Classroom work and on-the-job training are combined with tests of proficiency at intervals, so that a controller will not move to another part of the training until he can show that he has mastered the previous step.

At any enroute Center, there are three basic positions that may be worked by a controller; of the three, the controller who is in communication with the aircraft is the radar controller. It is this position for which a controller is last certified, and once he is certified for each radar position in the sectors of his specialty, he becomes a fully-certified or journeyman controller. A certified controller alternates between positions and sectors within his specialty frequently.

*In recognition of the amount of technical information that must be learned by a controller, as well as the language and phraseology, a local state-supported university initiated a program about three years ago to give air traffic controllers two years' credit toward a college degree. They can earn a degree by completing the requirements for the other two years.
The other two positions within each sector have specific responsibilities which generally contribute to the information and procedures necessary for control of traffic. The manual controller functions as a nonradar controller. He maintains current flight data on the flight progress strips, issues departure clearances and coordinates as necessary with adjacent sectors and air traffic facilities. The handoff controller assists the radar controller with his duties and coordinates with adjacent sectors and air traffic facilities also. While the responsibilities are generally outlined, there is some flexibility and overlapping if necessary.

The amount of classroom instruction prior to the on-the-job segment for any position varies. It should be enough to familiarize the trainee with what he will encounter in his work. For a few weeks, I attended classroom instruction for controllers preliminary to the on-the-job training for the radar position. The classroom work was on general radar procedures; these were outlined by an instructor, while the students studied from the Air Traffic Control manual. Additional exercises were also given to the students, and they took examinations at various stages of the instruction. There was also instruction using a radar simulator, which provided computer-controlled situations of air traffic. For these problems, the students had to make
decisions about traffic control during time limits built into the problem. Unlike the earlier classroom instruction, which was general, for these problems the students were divided up into groups depending on their specialty, and the problems they received involved areas with which they had to become familiar.

Once a controller is certified, his work is still checked periodically. A controller must monitor his own phraseology by listening to random tapings of his work about every six months, and there are local and national examinations for him to take each year. A controller's job is unique—the training is lengthy and specialized, and it is not specifically useful for any other occupation. On the other hand, only a trained controller can do this work.

A controller is anonymous and invisible both to the pilots with whom he communicates, and to the general public. The only controller who is visible in any way is the one in the control tower. Thus, in the portrayal of dramatic situations in which the assistance of a controller is required, it is always seen calling the control tower. This seems a matter where the plane happens to be the only time the control tower would could be if the aircraft were within port. Assistance needed at other times from controllers in an enroute Center or
The anonymity of controllers is supported by their working procedures. When they work, they are not individuals, they are traffic controllers. They identify themselves by the name of the Center in which they work, and sometimes by the sector. There is no particular part of this job that is the responsibility of any particular individual. Controllers work any position at any time. Within any specialty, one controller may leave for lunch, and another will take over without any interruption or delay. Even when controllers communicate with other controllers, they use working initials that are not part of their personal names.

All this adds up to a job in which the only important thing is the control of air traffic. This occupation has developed in a culture that is highly industrialized, with a sophisticated technology. A controller uses equipment that is more recently developed than the airplane itself, and which is continually being changed and improved. Basic equipment includes radio, radar with microwave relays, and the computer. To some extent, flying can be considered transcultural, since the rules and regulations which govern flying are international and are a part of any culture of which flying has become a part. My study, however, concerns the language and phraseology of United States air traffic controllers, its basis and use, as interpreted through my study and observations in the Air Route Traffic Control Center in Houston, Texas.
Since the work of controllers is in a general sense the giving of directions, the procedures and basis for their directions may be contrasted with a report of Einar Haugen in "The Semantics of Icelandic Orientation." Haugen writes about the work of Stefan Einarsson on terms of directions in Icelandic and points out that:

Einarsson's studies bring out the fact that in addition to the meanings which jibe with the compass directions, these words have meanings that vary from community to community. In Einarsson's native valley of Breiðdalur in Southeast Iceland, people speak of going east when they are actually going northeast, and contrast it, not with west but with south, when they are actually going southwest... But no sooner does one pass into the northeast section than the terms are reversed, and east is used about southeast, while north is used about northwest." (1969:330).

Since the control of traffic in our technological society involves outlining procedures and giving directions, these directions utilize the navigational aids and equipment that are an integral part of flying. Any locations and directions must be clearly understood from any reference point. This can be accomplished by the use of navigational aids; these have values that do not change from one situation to the next. For traffic control, it is important to know not only where an aircraft is heading, but what the present location is and how fast it is moving. The altitude of an aircraft is also important. All this can be determined by the use of equipment in the plane and/or on the ground.
If a pilot is flying VFR, he plans his own flight using such navigational aids, and when he flies IFR, the controller uses this information in the control of traffic. Both the pilot and controller must be able to understand navigational information and must know how to interpret it; this knowledge is required by FAA rules. The FAA determines and regulates the use of all navigational instruments.

These instruments form the basis for determining directions in flying. The basic directions of north, east, south and west, and the many possible directions in between are indicated by a compass in the aircraft. This compass is directed to magnetic north (which is one thousand miles south of the true or geographic North Pole). The use of a compass with a constant reference point means that any direction would have the same meaning at any time.

A pilot also uses maps to assist him on any flight. A map may be used by a pilot to identify certain land features or cities, if he flies low enough on clear days to do so; and a pilot flying above clouds can use a map to check his progress from one navigational aid to another. Navigational aids in the aircraft coordinated with naváids on the ground indicate to a pilot the course he is flying. Any controller the pilot would communicate with would already know any special features of the terrain along with fixes and reference points, so that he would be able to coordinate traffic safely and efficiently.

For a pilot or controller, the location of a geographic
area can be indicated in more than one way, and there are different kinds of aeronautical charts. One type of chart is based on lines of latitude and longitude. Longitude lines drawn from north to south begin with 0 degrees at the Prime Meridian. This is drawn through the observatory at Greenwich, England. The line of 180 degrees longitude is drawn through the Pacific and is called the International Date Line. Longitudinal locations are given in degrees west or east.

Latitudes, on the other hand, are drawn east and west, with the line through the Equator labeled 0 degrees. Latitude lines are designated from 0 degrees to 90 degrees north and from 0 degrees to 90 degrees south of the Equator. With such a system, a location can be determined by latitude and longitude intersections. Charts contain latitude and longitude lines for each degree interval; additional divisions for more accuracy can be obtained by dividing degrees into minutes—each degree is divided into sixty equal segments. Thus, locations of airports and cities as designated by geographical coordinates (such as 42 degrees 15 minutes north, 76 degrees, 18 minutes west) can be given fairly accurately with the same understanding at all times. In this example it would mean that this geographic point is located 42 degrees and 15 minutes north of the zero line of latitude (the Equator) and 76 degrees and 18 minutes west of the Prime Meridian. It is because of the use of latitude and longitude in geographic locations that
nautical miles are used in aviation. One minute of longitude or latitude is roughly equal to one nautical mile, while sixty minutes equals one degree.

Other kinds of maps or charts are also available in flying. There are two basic types: those that show significant topography and most aeronautical information and those that indicate mainly radio navigation facilities and routes. A pilot would use any type of chart that would be of use to him for a particular flight. There are also special airport maps or diagrams that pilots would use to understand the layout of an airport. Whatever aid a pilot or controller uses for location or direction, the values of reference points must be the same for all situations and for all directions.

In using the compass, it must be remembered that since the aircraft compass points to magnetic north, adjustments must be made in planning directions and courses. The angular difference between the direction to true north and direction to magnetic north is called magnetic variation, or simply variation. An example of such variation would be that if an aircraft were flying a true north heading over the panhandle of Nebraska, the aircraft compass would read 348 degrees rather than 360 degrees because the magnetic variation is 12 degrees east (of true north). If the aircraft were to fly south at the same point, the compass would read 168 degrees instead of 180 degrees. (The variation would be the same for either direction) (Private Pilot Manual: 7-4).
Pilots flying IFR under air traffic control must have charts and the appropriate navigational aids to keep to the courses that are specified by the controller. Airways are based on a centerline that is plotted from one radio navigational aid to another specified for that airway. An airway includes airspace within parallel boundary lines, which are normally four nautical miles on each side of the airway. For efficient control of traffic, a pilot must be able to keep an accurate course.

A system of navigation developed in the late 1940's called the "very high frequency omnidirectional range" (VOR) makes it possible for a pilot to fly such an accurate course. VOR stations located on the ground transmit beams called radials outward in all directions. A receiver in an aircraft is used to detect these signals and thus indicate on which radial the aircraft is located. The location of these VOR stations is called a fix. A pilot may use VOR in plotting his course to or from any location; the VOR receiver in an aircraft is calibrated to reflect 360 separate radials. It is accurate to a tolerance of one degree. The radials are magnetic compasses and many are used to form airways that connect most VOR's. Runways at airports are coordinated with radial directions so that when flying to an airport along a certain planned radial, the plane will be lined up for landing on the runway.

VOR stations are identified by means of a coded signal,
which is automatically and continually broadcast. Tuning in to the frequency of the station and following the compass bearing indicated by the needle, a pilot can easily find his way to the VOR. A navigational aid similar to VOR is TACAN (tactical air navigation) has an additional feature that deals with distance measuring equipment (DME). Use of the automatic direction finder (ADF) provides assistance in flying the low/medium frequency range, and makes it possible for navigation to proceed to or from any nondirectional low or medium frequency radio station. ADF can be used with compass locators utilized by instrument landing systems, nondirectional radio beacon, and standard (AM) broadcasting stations.

All of the navigational information on which flying is based and on which controllers depend for their work is standardized and must be learned by all pilots and controllers alike. The concepts of time and the use of time is also understood. Time of the day for controllers is "zulu" time, or Greenwich Mean Time (GMT). This is based on the day divided into 24 hours and is the time at the observatory in Greenwich, England (location of the Prime Meridian). Time reports are given in minutes past the hour; an aircraft reports over a fix in minutes. GMT time can be converted to local time, if necessary or desirable.

Interestingly, the conventional clock does have a
place in flying, but not to give the time of day. The clock is used as a positional aid when issuing traffic information to pilots. A controller might issue a traffic alert to a pilot as "aircraft at 3 o'clock, six thousand feet northbound," or "traffic 10 o'clock, unknown altitude, eastbound." This clock is oriented to the pilot's point of view. An aircraft at 12 o'clock would be an aircraft directly ahead.

Once the controller (and the pilot) know all there is to know about flying under all conditions, communication between them is facilitated to the point where it is based on knowledge and expectation that makes it possible to send and receive vital information quickly, easily, concisely and briefly with optimum understanding.
V. LANGUAGE AND PHRASEOLOGY

The language used in air traffic control can be thought of in two basic categories: as the medium in which an air traffic controller works, thinks, and makes decisions, and as the means of communication.

A controller's training consists not only of learning the basic knowledge and information, but equally in learning a technical phraseology having special terms, definitions and concepts. This official phraseology is an integral part of the overall language and knowledge of air traffic controllers and is used as specifically outlined in the procedures. Use of this phraseology is necessary, and such use is specified in great detail for anticipated occasions, although in appropriate situations a controller has the option and right to fall back on supplementary communication where the phraseology is deemed ineffective or insufficient.

The job and the basic aims of the air traffic control service have not changed since the early years of the work.
The 1952 manual used for air traffic control (the revised second edition) was entitled "ANC Procedures for the Control of Air Traffic." These procedures were to be used for the U.S. Army, Navy, Air Force, Coast Guard and Civil Aeronautics Administration. At this time, the objectives of air traffic control service were to "promote the safe, orderly, and expeditious movement of air traffic." These were further defined more specifically as follows:

1. Preventing collisions between aircraft and between aircraft and obstructions on the movement area.
2. Expediting and maintaining an orderly flow of air traffic.
3. Assisting the person in command of an aircraft by providing such advice and information as may be useful for the safe and efficient conduct of a flight.
4. Notifying appropriate organizations regarding aircraft known to be or believed to be in need of search and rescue aid, and assisting such organizations as required (5-6).

The current manual entitled "Air Traffic Control," issued in January, 1976, defines air traffic control service as being "provided for the purpose of promoting the safe, orderly, and expeditious flow of air traffic including airport, approach, and enroute air traffic control service (6). While the purpose of the manual itself is to prescribe air traffic control "procedures and phraseology" to be used "by personnel providing air traffic control services" (Foreward),
further information simply states that controllers must be familiar with the provisions of the handbook "which pertain to their operational responsibility and to exercise their best judgment if they encounter situations not covered by it" (Foreward). As complexity and variety increased in this work, the job became more difficult to outline—except in regard to the basic aim. The vast increase in procedures and phraseology reflect increases in technology and in air traffic, as well as in the variations in kinds of air traffic that have take place through the years.

Since the stated purpose of the job of air traffic controller is the same today as in the early days of air traffic control, there are many examples of procedures and phraseology that are similar now to what they were in 1952. Among these has been the use and communication of numbers. Communication of numbers was outlined in 1952 as follows:

Figures indicating hundreds and thousands in round numbers up to and including 9000 shall be spoken in hundreds and thousands as appropriate. Examples:

<table>
<thead>
<tr>
<th>Number</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>FIVE HUNDRED</td>
</tr>
<tr>
<td>1300</td>
<td>ONE THOUSAND THREE HUNDRED</td>
</tr>
<tr>
<td>4500</td>
<td>FOUR THOUSAND FIVE HUNDRED</td>
</tr>
<tr>
<td>9000</td>
<td>NINE THOUSAND</td>
</tr>
</tbody>
</table>

Numbers above 9000 shall be spoken by separating the digits preceding the word
"thousand." Examples:

<table>
<thead>
<tr>
<th>Number</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>10000</td>
<td>ONE ZERO THOUSAND</td>
</tr>
<tr>
<td>13000</td>
<td>ONE EIGHT THOUSAND</td>
</tr>
<tr>
<td>18500</td>
<td>ONE EIGHT THOUSAND FIVE HUNDRED</td>
</tr>
<tr>
<td>27000</td>
<td>TWO SEVEN THOUSAND (56)</td>
</tr>
</tbody>
</table>

Numbers referring to time were specified in this manual to be stated in four figures, utilizing the concept of 24 hours. "The hour shall be stated by the first two figures and the minutes by the last two figures. Examples:

<table>
<thead>
<tr>
<th>Time</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000 (Midnight)</td>
<td>ZERO ZERO ZERO ZERO</td>
</tr>
<tr>
<td>0920 (9:20 a.m.)</td>
<td>ZERO NINE TWO ZERO</td>
</tr>
<tr>
<td>1200 (Noon)</td>
<td>ONE TWO ZERO ZERO</td>
</tr>
<tr>
<td>1643 (4:43 p.m.)</td>
<td>ONE SIX FOUR THREE (57)</td>
</tr>
</tbody>
</table>

This manual further stated that in airport traffic control radiotelephone communications, time may be stated in minutes if there is no likelihood of misunderstanding, and that unless a time check is required, time shall be stated to the nearest minute. For a time check, time should be stated to the nearest quarter minute, as in the following example:

10:04.17    ONE ZERO ZERO FOUR AND ONE QUARTER.

Further information about time is stated as follows:

The 24-hour clock day begins and ends at 0000 (midnight). The last minute of the last hour begins at 2359 and ends at 0000, which is the beginning of the first minute ending at 0001 of the first hour of the next day. (57).

The importance of time and the need for complete understanding in its use is the same today as it was in 1952.
Therefore, numbers usage, as outlined in the current manual is similar to its use in 1952. The current manual reads, in the section on numbers usage:

(1) General time information—the 4 separate digits of the hour and minutes, based on the 24-hour clock in terms of Greenwich Mean Time (GMT).

Example:-

<table>
<thead>
<tr>
<th>Time (12 hr.)</th>
<th>Time (24 hr.)</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:15 a.m.</td>
<td>0115</td>
<td>&quot;ZERO ONE ONE FIVE&quot;</td>
</tr>
<tr>
<td>1:15 p.m.</td>
<td>1315</td>
<td>&quot;ONE THREE ONE FIVE.&quot;</td>
</tr>
</tbody>
</table>

(2) Upon request—the 4 separate digits of the hours and minutes in terms of GMT, followed by local standard time equivalents.

Example:-

<table>
<thead>
<tr>
<th>Time</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1430 PST (2230 GMT)</td>
<td>&quot;TWO TWO THREE ZERO GREENWICH, ONE FOUR THREE ZERO PACIFIC&quot; (33).</td>
</tr>
</tbody>
</table>

For a time check, the word "time" is used and the hour, minutes and nearest quarter minute are given in four digits. An example would be:

1212 3/4 TIME, ONE TWO ONE TWO AND THREE-QUARTERS.

To make use of abbreviated time, the minutes only are given in separate digits, as in the following examples:

<table>
<thead>
<tr>
<th>Time</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1530</td>
<td>THREE ZERO</td>
</tr>
<tr>
<td>1625</td>
<td>TWO FIVE</td>
</tr>
</tbody>
</table>

Other numbers' usage similarly involves giving separate digits:

22,690, to be read TWO TWO SIX NINER ZERO.

In altitude readings, however, the rule is separate digits for the thousands, plus the hundreds. An example is:
16,900 One six thousand niner hundred.

For altitudes 18,000 feet and over, the words "flight level" are followed by the separate digits of the flight level.

21,000 Flight level TWO ONE ZERO
25,500 Flight level TWO FIVE FIVE (33)

Changes involving numbers seem to be in the pronunciation of "niner" instead of "nine" and use of the words "flight level" preceding altitudes of 18,000 feet and above, although there are additional uses of numbers specified now for altimeter setting, surface wind, heading, radar beacon codes, runways, frequencies and speeds (34).

The use of time in approach procedures can be found in the manuals for 1952 and 1976. In 1952 the instructions state that timed approaches can be used if there is satisfactory communication between aircraft and approach controller. Instructions to the controller contain the following information:

The time interval to be used between successive approaches shall be determined by the approach controller and is dependent upon the speed of the aircraft, existing weather conditions, the distance from the holding fix to the airport and type of approach. Under optimum conditions a two-minute interval is the absolute minimum; this interval being increased as necessary in poorer weather conditions, or because of high speed aircraft following slower speed aircraft (87).

While there is a difference today in the relative speeds of aircraft, and there is the additional use of radar, the basic concept of time when it is used as a means of separation in approaches is not very different. Under the section "Timed Approaches" instructions state that these may be used
at airports served by a tower "using either nonradar procedures or radar vectors to the final approach course." One condition for use is that direct communication must be maintained with aircraft until pilot is instructed to contact tower (121).

Use a 2 minute or 5 mile radar interval (except for a small aircraft behind a heavy aircraft—use a 3-minute or 6 mile radar interval) as the minimum between successive approaches and increase the interval, as necessary, taking into account the:

a. Relative speeds of aircraft concerned.
b. Existing weather conditions.
c. Distance between approach fix and airport.
d. Type of approach being made. (122)

There are, however, other types of approaches contained in the 1976 manual, along with appropriate phraseology for the controller. There are instructions for circling approach, contact approach, single frequency approach, practice approach.

Little change can be noted in the basic list of "Words and Phrases" found in the section on "Radio and Interphone Communication." Instructions for the controller are to use these words and phrases "in radiotelephone and interphone communication, as appropriate:

ACKNOWLEDGE—"Let me know that you have received and understand this message."
AFFIRMATIVE—"Yes."
CORRECTION—"An error has been made in the transmission (or message indicated). The correct version is ..."
GO AHEAD—"Proceed with your message."
HOW DO YOU HEAR ME?—(Self-explanatory.)
I SAY AGAIN—(Self-explanatory.)
NEGATIVE—"No" or "Permission not granted" or "That is not correct."
OUT—"This conversation is ended and no response is expected."
OVER--"My transmission is ended and I expect a response from you."
READ BACK--"Repeat all of this message back to me."
ROGER--"I have received all of your last transmission"
(To acknowledge receipt; do not use for any other purpose.)
SAY AGAIN--(Self-explanatory.)
SPEAK SLOWER--(Self-explanatory.)
STAND-BY--"I must pause for a few seconds." (If the pause is longer than a few seconds, or if used to prevent another station from transmitting, add the ending "OUT.")
THAT IS CORRECT--(Self-explanatory.)
VERIFY--"Confirm."
WILCO--"I have received your message, understand it, and will comply."
WORDS TWICE--(As a request) "Communication is difficult. Please say every phrase twice."
(As information) "Since communication is difficult, every phrase in this message will be spoken twice." (32)

Following is the list from the 1952 handbook. Instructions state that these "words and phrases shall be used in airport traffic control radiotelephone communication when applicable " (58-59).

<table>
<thead>
<tr>
<th>Word or Phrase</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGE</td>
<td>&quot;Let me know that you have received and understand this message.&quot;</td>
</tr>
<tr>
<td>AFFIRMATIVE</td>
<td>&quot;Yes.&quot;</td>
</tr>
<tr>
<td>BREAK</td>
<td>&quot;I hereby indicate the separation between portions of the message.&quot;</td>
</tr>
<tr>
<td></td>
<td>To be used only where there is no clear distinction between the text and other portions of the message.</td>
</tr>
<tr>
<td>CORRECTION</td>
<td>&quot;An error has been made in this transmission (or message indicated). The correct version is.&quot;</td>
</tr>
<tr>
<td>GO AHEAD</td>
<td>&quot;Proceed with your message.&quot;</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>HOW DO YOU HEAR ME?</td>
<td>Self-explanatory.</td>
</tr>
<tr>
<td>NEGATIVE</td>
<td>&quot;That is not correct.&quot;</td>
</tr>
<tr>
<td>OUT</td>
<td>&quot;This conversation is ended and no response is expected.&quot;</td>
</tr>
<tr>
<td>OVER</td>
<td>&quot;My transmission is ended and I expect a response from you.&quot;</td>
</tr>
<tr>
<td>READ BACK</td>
<td>&quot;Repeat all of this message back to me exactly as received after I have given 'OVER'.&quot;</td>
</tr>
<tr>
<td>ROGER</td>
<td>&quot;I have received all of your last transmission.&quot; (To acknowledge receipt; shall not be used for any other purpose).</td>
</tr>
<tr>
<td>SAY AGAIN</td>
<td>Self-explanatory.</td>
</tr>
<tr>
<td>SPEAK SLOWER</td>
<td>Self-explanatory.</td>
</tr>
<tr>
<td>STAND-BY</td>
<td>If used by itself means &quot;I must pause for a few seconds.&quot; If the pause is longer than a few seconds, or if &quot;STAND-BY&quot; is used to prevent another station from transmitting, it must be followed by the ending &quot;OUT.&quot;</td>
</tr>
<tr>
<td>THAT IS CORRECT</td>
<td>Self-explanatory.</td>
</tr>
<tr>
<td>VERIFY</td>
<td>&quot;Check coding, check text with the originator and send correct version.&quot;</td>
</tr>
<tr>
<td>WORDS TWICE</td>
<td>(a) As a request - &quot;Communication is difficult. Please say every phrase twice.&quot;</td>
</tr>
</tbody>
</table>

The word "Break" which was used in 1952 is not found on the current list, and "Wilco" is in the current manual but not in the one for 1952. There are almost no other changes. The definition of "Negative" has been expanded, while "Read Back" has been shortened.

There have, however, been many changes in the whole
area of aviation since the early 1950's. These changes include different types of aircraft, increased size and speed of aircraft, and development of navigational aids. In the early 1950's, jet aircraft were relatively new, and a large air carrier would be able to carry about seventy passengers at one time. There were fewer navigational aids than there are today, and what there were had limited use. There were fewer aircraft than there are today.

While some of the procedures and phraseology remain much the same for some basic operations, there has been an enormous growth in the number of procedures generally, together with the addition of special procedures. Many now included in the handbook with the appropriate phraseology were undreamt of in 1952. Many of these now include radar.

The first radar used for air traffic control was identical to that used on ships (from which it was adopted) and was of limited use. Subsequent development of radar, however, increased its value and use in air traffic control and made possible many additional procedures. Radar operations are now an integral and vital part of air traffic control; it is probably safe to say that control of traffic in many areas of our country today would be almost impossible without radar.

The most recent manual issued for air traffic control is many times larger than the one used in 1952. Listed at the beginning of the 1952 manual are 45 definitions that have to do with air traffic control; among these are six acronyms. In 1976, this increased to 201 definitions, with a separate
list of 135 abbreviations or acronyms. There are other abbreviations and acronyms listed elsewhere, including those in special manuals that contain military operations, as well in letters of agreement.

That there are changes in any language is a recognized fact in linguistics. Hockett writes that "In every living language, new idioms are constantly being created, some destined to occur only once or twice and then to be forgotten, others due to survive for a long time" (1958:303). These changes in language are in response to needs stemming from other changes in the culture. Language changes may reflect changes in social structure, social interaction or technological changes. A language must change if it is to remain effective.

The phraseology and language changes in air traffic control, and the phraseology included with the procedures added through the years, have reflected the needs created by additional traffic and changes in technology, both in aircraft equipment and in equipment for the controller. Such changes, which can be seen by a diachronic study of the phraseology/language, have been conscious and planned, and have been accompanied by change and development in the organization and arrangement of the work of air traffic control. These were necessary for efficient and effective traffic control.

One such change has been the added "Terms of Reference" for the benefit of the controller in interpreting instructions as listed in the manual. Such specific meanings subsequently indicate his responsibility when using these instructions in
communication with a pilot for traffic control. Precision in interpretation may be vital at times. The handbook states:

As used in this manual, the following have the meaning shown:

a. "Shall," or an action verb in the imperative sense, means a procedure is mandatory.

b. "Should" means a procedure is recommended.

c. "May" or "need not" means a procedure is optional.

d. "Will" means futurity, not a requirement for application of a procedure.

e. Singular words include the plural.

f. Plural words include the singular.

g. "Aircraft" means the airframe, crew members, or both.

h. "Approved separation" means separation in accordance with the applicable minima in this manual.

i. "Altitude" means altitude mean sea level, flight level, or both.

j. "Miles" means nautical miles unless otherwise specified, and means statute miles in conjunction with visibility.

k. "Course," "Bearing," "Heading," and "Wind Direction" information shall always be magnetic unless specifically stated otherwise.

l. "Time" when used in the context of a clock reading is the hour in Greenwich Mean Time (GMT) or the local equivalent, as appropriate, and the minutes. Change to the next minute is made at the minute plus 30-second point, except for time checks which are given to the nearest quarter minute. (1)

Another instance in which special use is accorded to a word is listed under "Expeditious Compliance."

Use the word "immediately" in phraseology only when expeditious compliance is required to avoid an
imminent situation. If time permits, include the reason for this action.

These terms of reference and their special use are not included in the 1952 manual.

It would be possible, but not within the scope of this study to give examples of most of the situations that a controller must deal with, along with the appropriate phraseology. The safe, orderly flow of air traffic covers many possible situations. It may be mentioned also that since the work of a controller is explicit, merely describing his work is unnecessary. My study, however, resulted in some observations concerning the particular use of language in communication, and concerning developments in the structure of the official language over the years that may contribute to other work in the area of linguistics and sociolinguistics.

The knowledge of the pilot in all this is important, and he must learn the basic information about flying, together with the language and phraseology, weather and capabilities of the aircraft, as they pertain to him.

The basic phraseology that the pilot must know in order to be able to understand and communicate with an air traffic controller can be found in the Airman’s Information Manual, together with other information and procedures necessary for qualification as a pilot.

Part 1 of the Airman's Information Manual (AIM) contains a familiar list of words and phrases under "Radiotelephone Phraseology and Technique" (1-37).

The following words and phrases should be used where practicable in radiophone communications:
<table>
<thead>
<tr>
<th>Word or Phrase</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGE</td>
<td>&quot;Let me know that you have received and understood this message.&quot;</td>
</tr>
<tr>
<td>AFFIRMATIVE</td>
<td>&quot;Yes.&quot;</td>
</tr>
<tr>
<td>CORRECTION</td>
<td>&quot;An error has been made in this transmission. The correct version is . . .&quot;</td>
</tr>
<tr>
<td>GO AHEAD</td>
<td>&quot;Proceed with your message.&quot;</td>
</tr>
<tr>
<td>HOW DO YOU HEAR ME?</td>
<td>Self-explanatory.</td>
</tr>
<tr>
<td>I SAY AGAIN</td>
<td>Self-explanatory.</td>
</tr>
<tr>
<td>NEGATIVE</td>
<td>&quot;That is not correct.&quot;</td>
</tr>
<tr>
<td>OUT</td>
<td>&quot;This conversation is ended and no response is expected.&quot;</td>
</tr>
<tr>
<td>OVER</td>
<td>&quot;My transmission is ended and I expect a response from you.&quot;</td>
</tr>
<tr>
<td>READ BACK</td>
<td>&quot;Repeat all of this message back to me.&quot;</td>
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<tr>
<td>ROGER</td>
<td>&quot;I have received all of your last transmission.&quot; (To acknowledge receipt, shall not be used for other purposes.)</td>
</tr>
<tr>
<td>SAY AGAIN</td>
<td>Self-explanatory.</td>
</tr>
<tr>
<td>SPEAK SLOWER</td>
<td>Self-explanatory.</td>
</tr>
<tr>
<td>STAND BY</td>
<td>&quot;If used by itself means 'I must pause for a few seconds.' If the pause is longer than a few seconds, or if 'STAND BY' is used to prevent another station from transmitting, it must be followed by the ending 'OUT.'&quot;</td>
</tr>
<tr>
<td>THAT IS CORRECT</td>
<td>Self-explanatory.</td>
</tr>
<tr>
<td>VERIFY</td>
<td>&quot;Check with originator.&quot;</td>
</tr>
<tr>
<td>WILCO</td>
<td>&quot;I have received your message, understand it, and will comply.&quot;</td>
</tr>
</tbody>
</table>
WORDS TWICE
(a) As a request: "Communication is difficult. Please say every phrase twice."
(b) As information: "Since communication is difficult, every phrase in this message will be spoken twice."

Other procedures that are considered important for the pilot are outlined along with appropriate phraseology. Such basic procedures and phraseology are required by the FAA to be a part of the training of a pilot necessary before he can obtain a license.

The official phraseology of controllers (and pilots) is based on the use of elliptical syntax. The choice of words is given careful consideration, along with the word arrangement in order to convey necessary information and meaning in communication that is as brief and clear as possible. Such ellipsis is effective because it is standardized and learned; it is based on known and expected events, and it takes place in an environment which is cognitively understood by all those engaged in the communication. The concepts important in flying, and the value and interpretation of whatever information and events are present, should have the same meaning for both controller and pilot. The presentation and the pronunciation of the words that make up the elliptical syntax were selected to prevent misunderstanding through aural or cognitive misinterpretation. When numbers are used for any identification—for radials, time, speed, or altitude, they are pronounced and presented in a particular manner. To issue instructions to a pilot to change altitudes, climb is
used as the opposite of descend. In the following phrase, used to inform an aircraft when a vector will take it across a previously assigned nonradar route, the word "across" is used in preference to the word "through." (In this case "through" could be confused with "to.") The instruction reads: "EXPECT VECTOR ACROSS [Navaid radial] [airway/route FOR [purpose]." (163).

In the event there is needed clarification of any letters or words, the ICAO (International Civil Aviation Organization) phonetic alphabet may be used to spell them out.

The official phraseology generally contains common English words which have been selected for particular usage, and which convey particular meanings and emphasis through their use. Since it is based on specific knowledge, it is possible to communicate much while saying little.

A specified radio message format is listed in the manual; radio communication should be initiated with an aircraft by using this format.

a. Initial call-up:

(1) Identification of the aircraft being called.
(2) Identification of the calling unit.
(3) The type of message to follow, when this will assist the pilot.
(4) The word "Over" if required.

Examples:
"Apache six one Papa, Chicago Center, over."
"Apache six one Papa, Chicago Center, clearance, over."

b. Replying to call-up from aircraft:
(1) Identification of the aircraft initiating the call-up.
(2) Identification of the replying unit.
(3) Transmit message, confirm identity, etc.
(4) The word "over."

Example:-
"Apache six one Papa, Akron Tower, Squawk (code) IDENT, Over (if required)."

Once communication has been established, the same format is used for reply. However, after identification of the calling or replying unit, instructions are to "state the message to be sent or acknowledgment of the message received" (31). Instructions or clearance intended for a specific aircraft should be prefaced by identification of that aircraft.

Abbreviated transmissions may be used, and there are instructions listed for such use. Once communication has been established and the type of aircraft is known, instructions are to use the identification prefix and the last three digits or letters of aircraft identification. Abbreviation should not be used for similar sounding aircraft identifications, or for the identification of an air carrier or civil aircraft with an FAA authorized call-sign.

Examples:-
"Douglas one two three four five."
"Army six two seven one seven."

These may be shortened to:
"Douglas three four five."
"Army seven one seven."

After communication has been established, facility identification can be omitted.
Example:

"Douglas three four five, Denver Center, report passing Morton."

This may be shortened to:

"Douglas three four five, report passing Morton."

If messages are short, and receipt is generally assured, messages may be transmitted after call-up without waiting for aircraft reply. The word "over" may be omitted if a reply is obvious.

Example:

"Douglas three four five, Denver Center, over."
"Denver Center, Douglas three four five, over."
"Douglas three four five, Denver Center, say altitude"

Shorten to:

"Douglas three four five say altitude." (31)

Following is an example of communication interchange between a controller and various pilots, as he controlled traffic in his sector in January, 1976. This segment is all the communication of one controller during a period of his work. Since tapes are regularly made for routine monitoring by controllers of their own work, it was not difficult to obtain a random sample of communication. The specialty is the San Antonio Specialty, Kelly Sector.
Controller: Braniff fifty-six, clear of traffic. Contact San Antonio approach now, one two five point seven. Good evening.

Pilot: Twenty-five seven. Good evening.

Pilot: Center, this is Bonanza five four three five Delta.

Controller: Bonanza five four three five Delta, Houston Center. Go ahead.

P: Three five Delta is at eight point seven VFR squawking twelve hundred just west of Junction. We'll be landing El Paso. Can we have radar flight following please?

C: Three five Delta, contact Houston Center one two eight point four. The San Antonio altimeter is three zero two seven.

P: One twenty-eight four, Roger. Thank you.

C: Navy Bravo one one seven, contact San Antonio approach now, three five three point five. Over.

P: One one seven, three five three point five.

P: Houston Center, Bravo two three one is level, two three zero.

C: Navy Bravo two three one, Houston Center. Roger.

P: Houston, Tall one one at flight level four one zero.

C: Tall one one, Houston Center. Roger. Tall one one, descend at pilot's discretion, cross two five miles west of San Antonio at and maintain eight thousand, San Antonio altimeter three zero two seven. Expect vectors to approach course runway one four at Randolph.

P: Tall one one out of four one zero for eight thousand.

C: Tall one one, Roger.

C: Tall one one, now descend to cross four five miles west of San Antonio at one two thousand and below. Cross two five west of San Antonio at and maintain eight thousand.

P: Forty-five at twelve, twenty-five at eight.
Tall one one, contact Houston Center now, two seven eight point three. . two seventy-eight point three, over.

Tall one one.

Cherokee five four three niner five, radar contact lost. Cleared from Center frequency. Good day, sir.

Five four three niner five, Roger.

Houston, Braniff one forty-seven climbing to one seven oh. We're out of eight five.

Braniff one forty-seven, Houston Center, Roger. Climb and maintain flight level two three zero.

Two three oh, and will you forward our request?

Say it, sir.

We'd like to go to one seven six, San Antone, three five six Ciudad, three five oh flight plan.

Sir, I got requesting three five zero. Did approach give you direct Ciudad?

Well, he asked if we wanted to go, but I never heard him say we were cleared that way. But we'll turn and go that way. Thank you.

Braniff one forty-seven, Roger. Fly heading of one seventy-five until receiving, then direct Ciudad Victoria.

Thank you.

Kelly Controller calls Laredo Controller on override feature.

Go ahead.

Braniff one forty-seven requesting three five zero as a final.

How about three three zero, and I will negotiate for thirty-five.

All right. You want him to climb that way?

Flight level three three zero.

Yes, show it.
Laredo C All right.

Kelly Controller calls High Altitude Controller.

Kelly C Braniff one forty-seven is climbing to three three zero with your approval, and I'll give him to Laredo if that's okay.

High Alt.C That's approved.

Kelly C All right.

C Braniff one forty-seven, climb and maintain flight level three three zero, sir, and they are working for three five zero for you. Maintain flight level three three zero.

P Okay, three three zero. Thank you.

* * * *

The structure of elliptical syntax used in air traffic control phraseology has been developed because of necessities imposed by the nature of the work and the means of communication. Careful selection of words for maximum aural understanding and concise phraseology is the best means of communicating by radio in situations where time is short and understanding vital. The ellipsis, as outlined officially, is used routinely, and the fact that even further ellipsis often takes place in actual performance, demonstrates the success of this form of communication.

Use of ellipsis is encouraged by frequent instructions in the manual advising the controller that certain information in communication may be shortened (as noted in abbreviated transmissions mentioned earlier) or even omitted, as in instructions under "Radio Communications Transfer" (21).
When directing a pilot to change to the ground control frequency after landing, the frequency or numbers preceding the decimal point in the frequency may be omitted if, in your opinion, this usage will be clearly understood by the pilot concerned. (21).

The elliptical syntax in this case would consist of the controller saying to the pilot "CONTACT GROUND" or perhaps "CONTACT GROUND POINT SEVEN." The controller in this communication is saying, "You should contact ground control now on a frequency of one two one point seven megaHertz."

Another example can be taken from the manual where phraseology listed under "Pilot Requests" instructs the controller how to "approve or disapprove a request as circumstances permit." (22). The controller is instructed that if there is no more specific phraseology listed elsewhere for the applicable procedure he should approve a request by telling the pilot "APPROVED AS REQUESTED" or " (Requested Operation) APPROVED." He is saying "I am approving your request" or "Your request is approved." However, if he cannot approve the pilot's request, he uses the word "unable." The phrase then becomes "UNABLE (Requested Operation) " or simply "UNABLE." Using as a negative a completely different word (rather than adding "not" in front of "approved") not only makes the phrase shorter by one word, but it prevents the possibility of misunderstanding if the quality of the transmission is not good and the word "not" is missed. In this case he is saying "Your request is not approved," or "I am not able to approve your request."
Still another example of a word whose special use makes ellipsis possible is use of the verb "say" in the phrase "SAY ALTITUDE." Here the controller is asking the pilot to "Please tell me your present altitude."

Since elliptical syntax is based on common knowledge, not only of general concepts and values in flying, but on the particulars of any flight, the initial communication in any sequence of exchanges between controller and pilot is important. This is necessary for identification of an aircraft. When a pilot first contacts a controller, the controller is authorized and expected to repeat the pilot's identification as he gives it in order to reinforce understanding in communication. Once this identification is established, the controller is well prepared for further communication since he already has information concerning the aircraft, pilot, and flight. This further communication can then utilize elliptical syntax. When a controller tells a pilot to "CLIMB AND MAINTAIN SIX THOUSAND" or "DESCEND AND MAINTAIN SIX THOUSAND," he is saying to the pilot "You should climb now to six thousand feet and maintain that altitude," or "You should descend now to six thousand feet and maintain that altitude."

The efficiency and brevity of the syntax used in communication is aided by the fact that acknowledgment of communication can be contained in the repetition of all or part of the information received. The pilot's response to the controller's instruction to "Contact ground point seven," might be simply "Point seven." He would not have to say
"Roger" or give any other acknowledgment. His repetition of an important part of the communication lets the controller know that he has correctly received the controller's instruction or information and has understood it.

Communication between a controller and pilot can be very brief if the reason for the communication is routine and frequent. In one particular instance the acknowledgment of the pilot is indicated by his subsequent action, and if satisfactory, no additional acknowledgment is needed on the part of the controller. When a controller is trying to identify a radar target he would simply state the call-sign of the aircraft followed by the word "IDENT," or the words "SQUAWK (code) AND IDENT" (154). The controller here is saying "I am requesting that you activate the "IDENT" feature of your aircraft's transponder. The pilot would not reply verbally, but would simply perform the necessary operation with the transponder; this would subsequently be seen by the controller on the radar screen.

In another situation, phraseology to be used by a controller in an airport tower to authorize an "intersection takeoff if the pilot requests it" is contained in the manual (212). This phraseology reads: "RUNWAY (runway number) INTERSECTION DEPARTURE, (remaining length) FEET AVAILABLE." Here the controller is saying "I am authorizing an intersection takeoff from runway. . .There are . . . feet available from that point."

Airport controllers must advise pilots of vehicles,
equipment or any activity in any movement area that would be of concern to the pilot. Examples of such phrases are as follows:

MOWER TO LEFT OF RUNWAY.
TRUCKS CROSSING RUNWAY TWO FIVE.
WORKMEN ON TAXIWAY.
AIRCRAFT TO LEFT OF RUNWAY. (200)

These could be translated into more complete sentences as follows:

You are advised that there is a mower to the left of the runway.
You are advised that there are trucks crossing runway two five.
You are advised that there are workmen on the taxiway.
You are advised that there is an aircraft to the left of the runway.

The words that are generally omitted in the syntax of air traffic control phraseology are articles, pronouns and conjunctions. It is important to note, however, that in order to utilize ellipsis, special adaptation of a word is sometimes made, as in the phrases using "unable" and "say."

The following instructions are listed under "Radar Arrivals" in the manual, and offer examples of phraseology which contains more than one instruction. Additional brevity can be achieved by leaving out part of a name. Earlier this was demonstrated by the use of "ground" instead of "ground control"; it is also used when "tower" is used to refer to "control tower." In the following communication "intersection" is understood as referring to "Alpha," and in the second communication "outer marker" is understood. The situation for which the phraseology is outlined is listed
under "Arrival Instructions" (185).

...The aircraft is established on the final approach course, beyond the approach segments, 8 miles from Alpha at 6,000 feet. The MVA for this area is 4,000 feet.

EIGHT MILES FROM ALPHA, CROSS ALPHA AT OR ABOVE FOUR THOUSAND, CLEARED FOR ILS RUNWAY THREE SIX APPROACH.

The controller is saying:

You are eight miles from the Alpha intersection, and you should cross this intersection at or above 4000 feet. You are now cleared to follow the published ILS (instrument landing system) approach to runway three six.

Another example of radar arrival phraseology is as follows:

...The aircraft is being vectored to a published segment of the final approach course 4 miles from Lima at 2,000 feet. The MVA for this area is 2,000 feet.

FOUR MILES FROM LIMA, TURN RIGHT HEADING THREE FOUR ZERO, INTERCEPT THE LOCALIZER AT TWO THOUSAND CLEARED FOR ILS RUNWAY THREE SIX APPROACH.

You are four miles from the Lima outer marker. You are to turn right to a heading of three four zero and intercept the localizer at 2000 feet. You are now cleared to carry out the published ILS approach to runway three six.

Ellipsis in air traffic control phraseology takes place in different ways. There is first the simple omission of pronouns, articles and conjunctions, as well as most adjectives and adverbs. (Special mention may be made of the particular use of the word "immediately" for expeditious compliance.) If any doubt ever exists, however, as to the understanding of any communication, additional words may be used. In the issuing of any instructions, directions, or the requesting of any information, the communication would generally begin with
a verb. Prepositions would be used as needed for identification in procedures and locations, as in "Mower to left of runway," or "...cross Alpha at or above..." Names consisting of more than one noun would often be shortened where understanding would not be affected. Where more than one instruction is given, conjunctions can be omitted, with the understanding that procedures in such instructions are to be followed in the order in which they are given. Ellipsis is also made possible by the special use of certain words, as in "Unable request" and "Say altitude." Another example of special meaning is contained in the list of "Words and Phrases." In this list, "affirmative" is listed as meaning "yes," but "negative" as a response may mean "permission not granted" or "it is not correct" in addition to "no."

It was earlier noted that changes took place in any language as a result of changes in technology, social structure and social interaction. The processes by which new words or idioms become part of a language seem to be complex and varied. Hockett writes that when a "thing or event" is a speech form and is given a special symbolic value, we have "the coining of an idiom" (1958:307). Where do these new words come from?

In outlining sources of new words, Lehmann writes that "analogy may be viewed as the central process in modifications introduced in grammatical systems" (1962:190) and that analogy "is a process by which morphs, combinations of morphs or linguistic patterns are modified, or new ones created, in accordance with those present in a language" (1962:178).
Lehman notes, in writing about changes in semantic systems, that the change in the context of linguistic symbols may be considered under the following categories.

1. reduction in contexts (to total loss).
2. expansion in contexts.
3. alteration of contexts.

The last is the most complex, for under it we deal with shifts from one geographical, technical or social dialect to another, the most frequent type of meaning change (1962:200-201).

The language used in the environment of flying contains words whose use has been expanded from other contexts as well as words that have been altered in their context. Lehman continues that the

term plane was formerly found largely in modest contexts of scientific materials. Until it is restricted by the knowledgeable younger generation who scorn it in favor of B-57, 707, DC-8 and the like, it has a tremendous range and frequency. Other items used in its linguistic environment, rev up, jet, flame-out, and so on have extended their contexts from near zero.

To add to Lehmann's examples, it may be noted that there are words used in aviation that have been adapted from other uses in an expansion of contexts. As an example, there are terms relating to boats and to transportation by ship which were adapted for early aircraft and flying. An aircraft has a propeller and a rudder, although it also has wings and ailerons. A pilot flies an aircraft. When a pilot is in command of an air carrier he is called the Captain; his crew includes attendants who are stewards or stewardesses, and they all perform their work on board the aircraft.
Lehmann notes the interaction of geographical, technical and social dialects "in the complex languages of today" and adds that "semantic change by alteration of context is readily attested" (1962:203). He believes that of all the contexts which are altered the most frequent alterations take place in technical dialects.

Although the language and phraseology of air traffic control is specially defined and outlined with instructions for use, there are terms included that may sound familiar but would have meaning for controllers and pilots that would not be understood in the same way by anyone else. For example, a "recovery" refers to procedures specified for a military pilot to follow after he has finished his particular assignment or maneuvers, which procedures will eventually take him back to the airport. It may be noted that subsequent expansion of this word took place when it was used in the space program to describe the final segment of the trip of a space vehicle.

During my study of air traffic control language and phraseology, however, I became aware that in addition to the many words and phrases that had been adapted for use by air traffic control, there were also many words that I could not understand on any basis. It became evident that most of the development in new idioms stemmed from the incorporation of acronyms. These consisted not only of acronyms that referred to committees and groups, but which also referred to procedures, geographic areas and even the use of particular equipment.
Looking closely at these, the acronyms used by controllers can be divided into four categories.

I. Acronyms which are formed by the use of the first initial of two or more words taken from the name, title or description of some committee, group, procedure or equipment.

These acronyms are used in speech as either
(a) a combination of letters, e.g. FAA (Federal Aviation Administration), DME (distance measuring equipment), or
(b) pronounced as a word, e.g., MARSA (Military Authority assumes responsibility for separation of aircraft), MITO (minimum interval takeoff).

II. Acronyms which are formed of parts of two words or a combination of the initials and parts of two or more words. These are generally pronounced as words.

Examples are PIREP (pilot report--pertaining to meteorological conditions) and NOTAM (notice to airmen).

III. Acronyms which may be considered as second-order acronyms. In this case a part of one acronym is used in the formation of another acronym.

Examples are VDF (very high frequency direction-finding station), VOR (very high frequency omnidirectional range). The "V" in these acronyms stands for VHF (very high frequency).

IV. Acronyms which may be considered as third order acronyms. In a third order acronym, two second-order acronyms become parts of still another acronym.
An example is VORTAC (very high frequency omnidirectional range collocated with TACAN-UHF navigational aid). TACAN stands for tactical air navigation.

Hockett writes that one "widespread mechanism of idiom formation is abbreviation: the use of a part for a whole" (1958:313). Included in this category he notes that in the administration of F.D. Roosevelt and during World War II, the custom of calling governmental and military agencies and programs by abbreviative nicknames, derived (usually via writing) from their full official titles, became very popular" (1958:315).

He continues that this led to two developments. In one, the initials might be read off as a word, and he writes that in some cases the official long title has been worked out with a conscious view to this kind of abbreviation: thus "Women's Auxiliary Volunteer Emergency Service" was chosen because its initials, "WAVES," spell an ordinary English word of apt denotation and connotation. . .

The second development was that if an organization changed its official name, "it may stick to one which yields the same abbreviation, so that the publicity value of the latter will not be sacrificed." As an example he gives the change of "Transcontinental and Western Air" to "Trans-World Airlines," thus keeping TWA (1958:316).

However, contrary perhaps to early practices in the formation of acronyms or sometimes for formation of acronyms in other cognitive environments, acronyms in air traffic control language are not formed to take advantage of an easily
pronounced combination of letters or of an easily remembered connotation. These acronyms have several forms, and their use in communication and spoken language varies.

Since acronyms are formed from parts of other words, instead of having two or more separate words necessary to refer to something, one "word" of two or more letters is used instead. These letters may be taken from the first initials of the original phrase or may be composed of a combination of initials and parts of other words. In each of these cases, the acronym forms a "word" which to all intents and purposes can be used in place of the several words it represents. Such a word will be as easily understood for those in the proper cognitive environment as the more lengthy reference.

Some acronyms become so familiar that they are almost never spoken in their entirety. Words such as VHF (very high frequency), UHF (ultra-high frequency), ADF (automatic direction finder), IFR (instrument flight rules), become so well known in meaning that further explanation is almost never needed or used. Some acronyms, however, are not so familiar and are occasionally explained.

While all acronyms can be used as words, they are not all pronounced as words. Of the 135 acronyms listed near the beginning of the manual, about 30 are actually pronounced as words, although there are others found in other sections of air traffic procedures. Those that are pronounced as words come from more than one category of acronyms. Some are from
the category containing words formed by initial letters of a phrase, and others are formed by a combination of initial letters and parts of words. Words in this latter category seem more likely to be pronounceable; since they contain more than a series of initial letters, their formation more often results in a combination of letters which are easier to pronounce and identify as a word.

Pronounceable acronyms formed by initial letters are JATO (jet assisted take-off) and ATIS (automatic terminal information service). Examples of acronyms which are pronounceable combinations of parts of two or more words include ALNOT (alert notice), AIRMET (airmen's meteorological information), AIRAD (airmen advisory), SIGMET (significant meteorological information), COPCOM (Controllers' Operations/Procedures Committee).

This category also has words that at first glance do not seem pronounceable, but they are pronounced as words. Examples are RNAV (area navigation), where the first letter is pronounced as a separate syllable, and INREQ (information request) pronounced "in/rek."

The category of acronyms formed from initial letters has an unusual example of pronunciation. ISJTA (intensive student jet training area) is pronounced "is/jay." For most acronyms, the pronunciation is simply learned along with learning procedures during training. However, there is one example contained in the Air Traffic Control manual.
which has its pronunciation included. Instructions to the controller read "Expedite movement of NIGHT WATCH Aircraft when NEACP (pronounced KNEECAP) is indicated in the remarks section of the flight plan or in air/ground communications" (20).

There seems to be a strong tendency to pronounce acronyms as words if possible. While there are some that are easily pronounced, there are other examples of pronunciations that are devised and must be learned. There is much variation in the use of acronyms. It may be noted that some acronyms are known by pilots, but many are not.

As words, acronyms have a different basis in their formation than many other idioms in our language. They do not result from an expanding context or altered context or from other special adaptation. They are originally descriptive phrases, and these descriptive phrases become contracted into words.

Many acronyms have become a part of air traffic control language in the last twenty years, and they have different characteristics. Acronyms seem to be useful in air traffic control language—whether this is because they may save time in communication by reducing verbiage could only be determined by studies of acronym usage in other parts of our culture.

In any language, the use of any particular idiom will depend on its value in the culture. The acronyms used by air traffic controllers will remain in use only as long as they are needed; they will then disappear unless their use
expands to other contexts and environments, becoming important in other parts of the culture. An illustrative case is the word "radar," now so familiar in our culture that no one thinks of it as an acronym. The use of this word is so common and widespread that it is no longer written in capital letters, as is common for acronyms, and it is not listed among the other acronyms in the manual. It is, however, included in the section on definitions; the definition includes information about radar and also mentions the original description "radio detection and ranging" from which the acronym was formed.

While acronyms are occasionally used as code words, air traffic control language has a separate category of code words. These words have a specialized use as clues in identification or as keys to information. Their use and importance last only as long as they are selected to serve a particular special purpose. These words, which for a limited time function in an altered context, convey a different meaning from that which might be indicated on another occasion in another environment. In many cases, such words are indexical—pointing to a larger amount of information than that indicated by the particular word or words. They may be used for military procedures which may not be explained, but which could indicate special procedures or handling.

Information indicated by codes may be of many kinds; sometimes code words are used for identification. For basic identification of civil aircraft, coded letters and numbers
are used. Here a particular letter or letters will indicate an aircraft's registry, whether it is foreign or American, and a following number would be further identification. United States aircraft identification begins with an N, United Kingdom with G, Saudi Arabia with HZ, Japan with JA, India with VT, Israel with 4X, etc. Further identification for aircraft may utilize code words—some of these are easier to understand than others. Air taxi services use the prefix "Tango," as in Tango November one two three four." A civilian airborne ambulance uses the word "Lifeguard" before the registration number of the aircraft, as in "Lifeguard Cessna two six four six" (ATC manual, 36).

The branches of the military services have a more complicated system of identifying aircraft. Sometimes certain code names will be associated with certain types of aircraft and subsequently with certain types of operations. Code names also may identify certain squadrons. Many of the code names are changed frequently. Military code names are specified by the FAA to be "pronounceable words of 3, 4, 5 or 6 letters followed by a 4, 3, 2 or 1 digit number, e.g. Paul two zero, Pat one five seven, Gaydog four" (ATC manual, 37).

Code words may also be used to identify special situations which may require special procedures in connection with an aircraft. When the President of the United States is aboard a military aircraft, this is indicated by the word "One" following the name of the military service, e.g. Army One, Marine One, Air Force One; if the President is
aboard a civil aircraft, the words "Executive One" are used. The words "Executive One Foxtrot" is used when any member of the family of the President is aboard any aircraft. Similar codes are used for the Vice-President and his family (37).

Code phrases may also identify the FAA Administrator or Deputy Administrator in air to ground communication. These phrases are "Safe Air One" for the Administrator and "Safe Air Two" for the Deputy Administrator (31).

There are coded words for "Special Operations." An example is where it is noted that it is necessary to "Provide expeditious handling for civil or military aircraft using the code name 'Flynet.' Relay the code name as an element in the remarks portion of the flight plan" (ATC manual, 287). When a particular word has been selected to indicate required special procedures, it is not necessary that any further explanation be given for the word or the reason for the procedure. Since use of the word as specified serves a particular purpose in a limited instance, the meaning is clear.

However, the use of code words in the language of air traffic control sometimes makes it possible to indicate additional information referred to by the word. One such opportunity for this is through the use of coded procedures used by pilots. There are many routine procedures in flying used by all types of aircraft; among these are the procedures followed in airport approaches and departures. When such
procedures are specifically outlined and routinely used as outlined, one can simply refer to the whole series of procedures through the use of a code word. In this way it is possible to cut down on the amount of communication between a controller and pilot during a period which may be busy for both.

When a pilot is cleared for a coded procedure, he receives a minimum of instructions; he is expected to proceed at specified altitudes to specified fixes which are contained in the procedures. The controller knows what procedures he has approved for the pilot to follow, and the pilot knows that the controller is aware of each step in this procedure also. In other words, the procedures are specified and recorded, and when approved, the pilot must follow them exactly.

If a controller approves a particular coded recovery, he must be certain that the pilot knows what is involved in these procedures. If the pilot did not have this information, or if he were prevented from following all the procedures, he could not receive approval for that particular procedure. In that event, the controller would have to issue other instructions for the pilot.

Following is a description of three coded recovery procedures. These are among several contained in a letter of agreement between Houston Center, NAS Chase ATCF (Naval Air Station Chase Air Traffic Control Facility) and Training Air Wing Three, dated August 15, 1974. The recovery covers
procedures leading eventually to approach and arrival at
Navy Chase (airport).

**CODED RECOVERY PROCEDURES**

**LOBO RECOVERY**
Cleared to NAS Chase via direct
to Chase TACAN 060 radial 26 NM
fix, thence via 060 radial and the
HI-TACAN RWY 31L approach, cross
the 060 radial 26 NM fix inbound
at assigned altitude. Maintain
15,000 feet to LOBO.

**PAWNEE RECOVERY**
Cleared to NAS Chase via direct to
Chase TACAN 304 radial 27 NM fix,
thence via 304 radial, and the HI-
TACAN RWY 13R approach. Cross the
TACAN 304 radial 27 NM fix inbound
at assigned altitude, cross the
304 radial 22 NM fix at or above
11,000 feet.

**BEE RECOVERY**
Cleared to NAS Chase via direct
maintain VFR conditions on top.
The Center will provide radar ad-
visories and effect radar handoff
to Chase ATCF at or below 11,000
feet. If unable to maintain VFR
on top until reaching 10,000 feet
the Center shall issue a LOBO or
PAWNEE RECOVERY.

The following exchange between a controller and a
pilot involves a pilot requesting and being approved for a
Pawnee Recovery. All of the communication covers the
procedures listed above under Pawnee Recovery. It may be
noted that there are procedures contained in the recovery that
are not mentioned specifically by either the controller or the
pilot. Each knows what is involved in this recovery, so that
when the controller issues approval to the pilot, both know
what procedures will be expected. After this segment of the
flight, the pilot will be handed over to approach control at
Navy Chase, and instructions regarding continuation of the flight will be given by a controller there.

This communication is an actual transcription between a controller working in a sector of the Laredo Specialty at Houston Center in January, 1976.

* * * *

C Roger, you're requesting a Pawnee recovery. Squawk four seven one four.

P Four seven one four.

C Charlie three three, Houston, IDENT.

C Charlie three three, radar contact one five miles southeast of Victoria.

P Roger.

C Charlie three three cleared to Pawnee DME fix via direct maintain one six thousand

P Navy Charlie three three cleared to Pawnee as an approach fix, maintain one six thousand.

C Charlie three three, Roger.

* * * *

C Navy Charlie three three descend and maintain one five thousand, Chase altimeter three zero one niner.

P Three zero one niner, Charlie three three out of one six thousand for one five thousand

C Charlie three three, Roger.

* * * *

P Houston Center, Navy Charlie three three.

C Charlie three three, go ahead.

P Navy Charlie three three like to request one practice turn in holding at Pawnee.

C One turn in holding at Pawnee approved. Then cleared recovery, squawk five two zero zero.
P Five two zero zero.

Controller calls Chase Approach

Chase Navy Charlie three three radar contact, three east of Pawnee, Channel ten.

C He's making one turn in holding.

C Navy Charlie three three contact Navy Chase approach Channel one zero.

P, Channel one zero.

* * *

In addition to the coded procedures concerning departures and arrivals for military aircraft, there are also special coded procedures for non-military aircraft. These include STAR (standard terminal arrival route) arrivals and SID (standard instrument departure) departures. STAR arrivals and SID departures are published and are available for approval and use by any pilot with the right qualifications (IFR license) and the proper equipment in his aircraft. It takes less time for a controller to clear a pilot for a "Scurry Two" arrival, which has the expected procedures already listed and outlined, than to have to outline such procedures in detail for each pilot. These procedures are routine, requiring approval by a controller. The approval for the procedures is given by the use of the coded name to which the procedures refer. In many of these cases the code name for the procedures includes the name of the particular fix used in the arrival or departure.

As already mentioned, the language and phraseology have the same characteristics and basis in their formation.
now as in the early days of air traffic control. However, besides changes that have been necessary because of technological developments and increased traffic, there have been occasional changes in words or content because of a demonstrated need for clarification; such changes continue to take place. These changes may be initiated by one of several routes, and after appropriate review and deliberation, they may be effected.

Amendments may be made because of input from controllers, along with consideration of a controllers' procedural committee called COPCOM. There is a national COPCOM, but there are local committees also. A suggestion made by an individual controller would be referred by a representative of his specialty to the local COPCOM. It would later be referred to the national committee. Another committee for evaluation may be FATA (Facility Technical Advisory Committee). Amendments may also be suggested by pilots' groups, for example the NBAA (National Business Aircraft Association); and management in the FAA may also suggest changes.

Safety in flying depends on a number of factors. The aircraft must be capable of functioning properly, and it must be under the control of a pilot who has the knowledge and ability to fly it under any conditions that may arise. There must also be understanding between a controller and pilot in situations where they are engaged in communication about air traffic control procedures. The work that goes into setting up and maintaining standards for flying in the United
States has resulted in an excellent record of safety in flying. However, the changes that do occur each year for clarification of procedures or of phraseology, indicate that even though every effort is made for complete understanding in communication, there continue to be times when a lack of understanding occurs. As mentioned, changes may be initiated by controllers or by pilots when there seems to be a need for clarification—sometimes, however, a lack of understanding may be revealed by a near mishap or actual mishap.

Such was the case in the investigation of the crash of TWA flight 514 on Dulles 1, 1974, near Dulles airport. After many months of investigation and testimony of many witnesses, the National Transportation Safety Board decided that the accident was due to

a combination of conditions which included a lack of understanding between the controller and the pilot as to which air traffic control criteria were being applied to the flight while it was operating in instrument meteorological conditions in the terminal area" (Aviation Week, March 1, 1976:66).

Further, the Captain did not act in response to his own doubt about the decisions he selected, because he did not request clarification from the controller.

Ironically, about one-half hour before the TWA accident, another air carrier flight approached Dulles from the northwest. This pilot was cleared for a VOR/DME approach to Runway 12. However, the pilot of that flight requested information regarding the minimum vectoring altitude at the
flight's position. He requested this because he was a considerable distance from the airport and had not been given an altitude restriction to use before arriving on a published approach segment. The controller gave the pilot the minimum vectoring altitude and also offered a surveillance radar approach to the flight. The captain accepted the surveillance approach and the aircraft landed without further incident.

The questions that concerned the NTSB were (1) why the crew of TWA 514 knowingly descended to 1,800 feet in an area where the terrain obstacles extended almost up to that altitude; and (2) why the controller did not include an altitude restriction under the circumstances of this case (Aviation Week, Feb. 23, 1976:60).

The review of the record supported the conclusion that the captain of the flight believed that when he approached the airport in a radar environment for a nonprecision approach he would not have been "cleared for the approach" without an altitude restriction unless he could indeed make an unrestricted descent to the final approach fix altitude (Aviation Week, Feb. 23, 1976:60). In order to try to determine why the captain believed this, the NTSB reviewed development of the use of radar in air traffic control and found that such development affected the pilot's understanding of his responsibility in this case.

It is such review of language and phraseology and procedures that enables pilots and controllers to understand
their work and its position in the overall environment of flying and to clarify situations that need clarification. This particular summary also helps illustrate some of the increases in procedures.

Before radar, the pilot was the only person responsible for knowing where the aircraft was in regard to the terrain. The pilot kept the controller informed of his intentions and of the aircraft's position. As a result, there were numerous calls during an instrument approach as the pilot reported his position, altitude and intentions.

With the use of radar, the controller could observe the aircraft in two dimensions—range and azimuth—and he was able to vector flights to arrive over geographical positions. Headings could be issued by the controller in order to keep known IFR traffic from converging. However, the pilot still had to advise the controller of the altitude of the flight. As the use of radar increased, "a new language was introduced to pilots and controllers and new procedures were instituted to provide for the control of IFR traffic in the terminal area" (Aviation Week, 2/23/76:60).

The controller's role thus became more important in the maneuvering of the aircraft through the issuance of headings and altitudes to pilots. This role increased as traffic increased and aircraft became faster; the controller was responsible for maintaining an uninterrupted flow of traffic to the runway.

With the added control of traffic in the hands of the controller, pilots have become more and more dependent on the
air traffic controller to control a flight's altitudes, headings and airspeeds. The increased dependence of pilot on controller has resulted in (1) less tendency to know the type of terrain over which aircraft is flying, and (2) occasionally limited information concerning position of aircraft relative to airport and obstacles on the ground.

Controllers must know air traffic control procedures and terminology associated with IFR flying and navigation. Pilots, however, must have knowledge of the operation of the aircraft, in addition to air traffic control procedures and phraseology necessary for the safe operation of aircraft in the airspace system.

In the flight of TWA 514, approach clearance was given to the flight without altitude restrictions because it was the understanding of the controller that the flight was not being handled as a radar arrival, and he expected the crew of the aircraft to conduct the approach as it was depicted on the approach chart.

The captain of the aircraft did not question the controller after receiving the approach clearance regarding the action the flight crew was supposed to take, although an earlier crew did so. While the captain noticed that the minimum altitude associated with the approach segment from Front Royal to Round Hill was 3,400 feet, he decided that the flight could descend to 1,800 feet because he was not on that segment (Aviation Week, March 1, 1976:66).

The results in this case indicated that the particular
procedures in this instance were not clear as outlined in
the FAA's Terminal Air Traffic Control handbook, and that
the terms "radar arrival" and "nonradar arrival" were not
defined (Aviation Week, March 1, 1976:66). Recommendations
of the NTSB included recommendations for ground warning systems
in air carrier aircraft, and a modification made to the ARTS 3
system "that will alert air traffic controllers when aircraft
deviate from predetermined altitudes while operating in the
terminal area (Aviation Week, March 1, 1976:67).

The phraseology has also been amended to include
issuance of altitude restrictions during nonprecision in-
strument approaches. This is already in effect.

This accident indicates that any problem in the com-
munication between controller and pilot was not in the concepts
or values of the environment, or even what the procedures
should be--it was which of those procedures were to be used
in this particular situation. All the information was avail-
able in this case, but there was a difference in interpretation.
This could have been resolved by more information given or
requested--but this did not occur. Each side was sure enough
of his understanding that there seemed no reason to question
interpretation.

In the cognitive environment of flying, there is
probably more effort made at understanding and agreement in
air traffic control language and phraseology than in most
other parts of our culture. This effort, combined with the
advantage of shared knowledge, undoubtedly contributes to a
high level of understanding between controllers and pilots. However, as indicated by the investigation of this accident and by other requested changes in phraseology and procedure, there are occasions when misinterpretation is possible. This would indicate that understanding in communication is probably not generally easy to achieve. Such problems in communication have implications concerning understanding in other parts of our culture.
This study of the language used in the work of air traffic control had several considerations. I was interested in finding out how understanding in communication worked when understanding was the desired aim; I was also interested in how this was accomplished. Also, since this was a secondary language, I wanted to examine the structure of this language to see how it worked in actual performance.

The concept of understanding in communication itself may be subject to different interpretations and probably could be discussed at length. There are undoubtedly many instances in the day to day contacts of individuals in our society where similar interpretation in any communication may be impossible, unlikely, or even unnecessary; understanding itself may be only in intent. This situation would be intolerable in air traffic control. It is obvious that from the nature of the work of air traffic controllers and the nature of the needs of pilots, the attempt at understanding must be largely
successful. This is possible because of the background of knowledge and information learned by both controllers and pilots, which background results in their sharing a cognitive environment in which the communication takes place.

In this cognitive environment, the communication and understanding work well enough to ensure safety for large numbers of aircraft each day. Understanding in air traffic communication is subjected to the most vigorous test of all—daily use by thousands of controllers and pilots. Any "incident" or "mishap," if it does occur, is thoroughly investigated in an attempt to determine the reason for its occurrence and to make certain that it will not occur again. Of the mishaps that do occur, it is known that very few are due to misunderstanding in communication.

However, it must be added that while misunderstandings are few, they are possible, and this is what is really important. Each year there are a few changes in air traffic control language and phraseology which result when controllers or pilots or FAA management become aware of a communicative situation which they believe could possibly cause a problem some day. Since interpretation and understanding are questioned, such clarifications take place as a preventive measure. Sometimes it takes a mishap or near mishap to indicate that a change should be made.

The most interesting aspect of any need for clarification, however, is the fact that it does occur. It reveals that even though great effort is continually made to have the
language and phraseology clearly understood, there are still times when there are different interpretations. It is an indication that understanding generally is not easy to achieve.

The overall success of the communication between controllers and pilots is largely because of the learning and training of both controllers and of pilots, which results in a common background of knowledge that both share. Controllers are trained according to a planned program, covering an average of four years, during which time their learning about flying and air traffic control ranges from very general information to the very specific information they eventually need for traffic control in their own specialty. Pilots on the other hand learn to operate a particular type aircraft while they also learn concepts and values that are necessary in the general environment of flying. The background of knowledge, training, testing and certification for all engaged in any aspect of flying is determined in turn by FARs (Federal Air Regulations), which are under the authority of the FAA (Federal Aviation Administration).

For this study, I considered air traffic controllers as a vocational group within our society who had a special language which they used in their work. While the fact that our society has a "complex language" which receives contributions from "social and technical dialects" has been noted by Lehmann (1962:202), and that our society contains occupational groups who have special forms of language
has been mentioned in sociolinguistic studies (Ervin-Tripp 1972:239), no previous studies have been made of a vocational group and its language.

One reason for this may be the difficulty associated with defining such a group for study. While for any culture or subculture, the language is considered to contain the rules employed by the individuals therein to categorize, code or define concepts and values in that culture, and verbal information is ascertained by knowledge of that culture, vocational groups are only identifiable on a limited basis. Still, however, for the purposes of the work and interests of any group, the language would undoubtedly reveal something about concepts and values important in that work. In ascertaining what concepts and values are important in the specialized activity of flying, it is possible to see how the work of controllers, (even though they are not physically engaged in flying), must take these into account. The basis for their knowledge, their study and learning and finally the structure of the language and its use, all must be cognitively aligned with the physical realities of flying.

The concept of a cognitive environment as a basis for the study of language of a vocational or common-interest group in our society, takes into consideration the important fact that many individuals in our society cannot easily be considered as members of only one particular group, as might be the case if an individual were referred to as a member of a "subculture." Many individuals in our society are members
of many groups, and any particular group is likely to have a different combination of individuals. Thus, an individual spends only part of his social or vocational life in any particular group, and it would be difficult to consider such an individual as a member of a "subculture."

Many vocational groups and common-interest groups have different vocabularies or languages that reflect the different concepts and values that are important to that group. Since an individual in our society may be a member of many groups, he would have knowledge of many special vocabularies or languages. If it is possible to determine what these concepts and values are, it may be possible to see how any group's language reflects these, in addition to revealing something about communication of the group.

Studying the language used by a particular vocational or common-interest group makes it possible to see that language does reflect special use by a group for a particular purpose. However, such special use is not always dependent upon a special environment. Controllers are able to learn concepts, values and knowledge important in flying without actually flying themselves. It also means that events concerning flying can be discussed with understanding in appropriate terms and language by controllers or pilots in different physical environments. This would be the equivalent of the "19th hole" in golf, or discussing a fishing trip at an evening gathering. For the purposes of language and communication, the cognitive environment does not have to be one and the same with a physical environment; a cognitive
environment may transcend a physical environment.

Communication between air traffic controllers and pilots is based on elliptical syntax. There is careful selection of word forms and arrangement in this syntax, to be certain of complete aural understanding as well as understanding in content. The choice of word forms in the phraseology is as important as is the means of delivery. The expected arrangement of word forms facilitates maximum understanding on the part of both controllers and pilots through expectation and practice, especially since it is already based on substantial knowledge of flying in general, in addition to the particular circumstances of any flight.

While the basic official phraseology is made up of elliptical syntax, further ellipsis is possible and actually is common in performance models. Much of the communication between controllers and pilots is what each expects, especially if the conditions of the flight are routine. The controller, having information about the aircraft, its route and destination and knowing that the pilot is aware of these also, need only give minimum information in controlling traffic. The controller is authorized to abbreviate or shorten communication if he has reason to believe this is possible in any situation. Working in a shared cognitive environment, fewer key words can convey meaning that both controller and pilot will understand. It is because of this sharing of knowledge and expectations that understanding and communication can occur with fewer and fewer word clues, so that there are
occasions where the final receipt of a communication is acknowledged by a pilot as a double-punch on the mike button, resulting in the "click-click" of his transmitter. The controller becomes expert at understanding minimal clues in communication.

When occasions arise in which it is deemed that the official phraseology is not adequate or effective, a controller is authorized to use supplemental words and phrases. In other words, in situations where there is less expectation or knowledge or routine, the language must become more complete. Such communication would be less elliptical. One conclusion reached here is that the important factor for the use of ellipsis is that the knowledge and background on which the communication is based must be shared by all in the communication. Ervin-Tripp writes that "ellipsis in the syntactical sense is clearly more common in informal speech" (1972:238). However, since ellipsis is possible when those engaged in the communication are operating in the same cognitive environment and who thus share knowledge and information that may be communicated with a minimum of words, speech in such a situation may often seem to be informal. It may, perhaps, be possible to discern use of ellipsis in speech in varied situations in our society when such situations involve communication between individuals who have the same background of knowledge and information. The more there is understanding of concepts and values in a shared cognitive environment, the more easily communication takes place with
fewer word clues.

While there has been no change in the basic aim of air traffic control, there have been changes in phraseology and procedures. Understanding between controllers and pilots is tested every day under operating conditions, and there are few instances where there is any problem. However, as previously mentioned, the fact that clarification is occasionally necessary in phraseology and language, and the fact that a mishap may reveal a difference in understanding, is some indication of the complex nature of understanding in communication. Even when much effort is made for complete understanding, there seems to remain some possibility of a difference in interpretation.

The greatest number of changes in the language of air traffic control has been in additional procedures. Since the early 1950's, there has been much technological development in aircraft, navigational instruments and in the equipment used by controllers. All of these changes and additions are reflected in the language and phraseology. Many of the new words are acronyms and their usefulness is indicated by the fact that the number increases each year. While this may be interpreted as a tendency toward abbreviation, which may not be unusual in an environment that stresses brevity in its language and phraseology, there have been increases in the use of acronyms in other parts of our society also. I believe that these increases have implications concerning cognitive processes.
The use of acronyms is found in government agencies, educational institutions, industry, sports, as well as in other areas. There is the FTC (Federal Trade Commission), NASA (National Aeronautics and Space Administration), NOAA (National Oceanic and Atmospheric Administration), IBM (International Business Machines), AAAS (American Association for the Advancement of Science). Baseball scores include RBI (runs batted in) totals, and football has the touchdown and the PAT (point after touchdown). It may be that parts of our society utilize acronyms more than others, and this would be interesting to investigate.

Increases in procedures and phraseology have also resulted in the increased use of code words in the language of air traffic control. Use of code words, however, is more specialized and more limited than the use of acronyms, although code-word usage can also be found in other areas of communication in our society, such as police work.

Any study of the developing structure of language may possibly give some indication as to what is involved in cognitive processes. Developments in language may be affected by the amount of information that is available to any individual at any time and may be related to attempts to more easily utilize the information. As mentioned, there were many technological developments in the area of aviation that contributed directly and indirectly to additional procedures in air traffic control. A technological change in one area might make air travel safer, more efficient, more practical,
and traffic would increase. Increased traffic would necessitate other changes, and more information and procedures would be generated. Changes such as these have been occurring not only in air traffic control, but in all parts of our culture in the last twenty-five years. For many technological changes, one thing is not exchanged for another, nor does only one change take place. A particular change or development in one part of our society may result in changes in many other areas. All of this has resulted in much more information being available and often necessary in many more areas.

Psychological tests have indicated that there are cognitive limits to what the mind can receive, process and remember. Miller writes:

> By organizing the stimulus input simultaneously into several dimensions and successively into a sequence of chunks, we manage to break (or at least stretch) this informational bottleneck. (1956:95).

Miller believes that through the important process of recoding, the mind can retain more information. He believes that such procedures concern clinicians, social psychologists, linguists and anthropologists. "In particular, the kind of linguistic recoding that people do seems to me to be the very lifeblood of the thought processes" (1956:95).

It seems to me that the increasing use of acronyms in our society may be a means of linguistic recoding, so that at any time, instead of using several words to refer to something, one acronym may be used. Code words as used
by air traffic controllers may also serve to indicate a
certain procedure or as a clue for other information.
The use of acronyms, as demonstrated in air traffic control
language, has increased significantly not only in the total
number but also in variations in their use. This seems
to be true in other parts of our society also. From the use
of acronyms first to indicate names of groups and committees,
they are now also used to identify a variety of situations,
locations, procedures, and equipment. There are also acronyms
that are used in the formation of other acronyms.

It should be possible and would be interesting to
investigate the use of acronyms and code words in other
parts of our society. The creation of acronyms as a method
of recoding seems to have much variation. Variations in
acronyms are indicated in the way they are formed, how they
are used, and how they are pronounced. Studies in other
parts of our society could determine whether the same bases
exist or whether there may be even more variation.

Any studies concerning the mind and cognitive processes
can only be made utilizing information that is obtained from
the mind. One way or another, this often involves language.
It seems that other studies based on language use within
cognitive environments for purposes of studying function and
structure of the language, could be useful in obtaining
information about cognitive processes also.
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