ABSTRACT

AUTOMATION IN THE BROADCAST INDUSTRY

By

James Horace Stone

Few, if any, industries have been able to claim immunity from technological change. In reality, few have wanted to do so, for most generally technological change has brought new and improved ways of accomplishing old and trite tasks. The evolution of change has brought with it a multiplicity of industrial concepts. None has been more potentially revolutionary than that concept which is described by the term "automation."

It is usually agreed that automation describes a process of manufacture which entails automatic assembly of the product from one stage of development to the next with minimal human intervention. Such arrangements of automatic equipment are known as systems.

As initially conceived, automation systems were most frequently applied to the manufacture or control of mass produced, tangible products. However, subsequent development, particularly in the field of systems application, has rendered automation desirable to those industries whose products are of an intangible nature.

The broadcast industry is among those latter-day industries which are turning to an automated concept of product production. Broadcast equipment manufacturers have created automatic equipment

capable of assembly into systems which are able to perform most routine tasks associated with radio and television programs. Automated systems for broadcast use can be subdivided and grouped by their respective functions. These subdivisions include automatic devices for monitoring of transmission equipment, those automatic devices used in production of programs, and automatic data processing equipment for office tasks.

While a system approach may be considered the most efficient form of automation, many broadcasters have adopted the procedures of automation through a building block approach, wherein a system which will adequately serve all departments of the broadcast stations is acquired over a period of time.

Regardless of the rapidity of acquisition, the success of automation techniques in the broadcast service ultimately depends upon a number of variables. Capital availability, employment costs, individual stations' standards of excellence, and adequate planning are all important considerations relative to adoption of an automated broadcast system.

A perspective on automation or any subject is usually sharpened through a thorough review and analysis of current authoritative information. Unfortunately, even manufacturers' descriptive material may often lag behind the lightning fast pace of technological advancements. As a result, compilations of basic material relative to such specialized areas as broadcast automation are scarce. It is toward the fulfillment of this information void that this thesis is directed.

AUTOMATION IN THE BROADCAST INDUSTRY

By

James Horace Stone

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Department of Television and Radio

1968

Accepted by the faculty of the Department of Television and Radio, College of Communication Arts, Michigan State University, in partial fulfillment of the requirements for the Master of Arts degree.

Leo Martin

Director of Thesis

ACKNOWLEDGMENTS

The writer wishes to acknowledge the guidance, interest, and assistance given to him by Leo Martin, Chairman of the Department of Television and Radio, Michigan State University.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

CHAPTER I

INTRODUCTION

The call today is for new ideas to cope with an old force--that of technological change. Technological change is nothing new in the history of civilization. It has been suggested that:

> Man as a thinking being is also a doer--always looking to improve. Sometimes he is motivated by the economics of a situation: sometimes by an innate laziness that leads him to conceive labor-saving techniques; and sometimes by a simple urge to find a better-than-usual way of doing things.[1]

Historical Development of Automation

To see technological change in its proper perspective one should take a look backward toward its beginning--almost to the beginning of civilization itself. The following list provides some landmarks which tell approximately when and where important steps of technological change were made:

B.C. 4000	Rollers; handles on tools; simple levers and prys; oxen to haul sleds.
B.C. 3500	Wheeled carts in Mesopotamia.
B.C. 500	Pulley in use.
B.C. 250	Archimedes improves use of pulleys, levers, screws.
A.D. 250	Wheelbarrows in China.
A.D. 300	Horse-collar in China, enabling horses to haul heavy loads.
A.D. 1800	Steam power in England and Europe.
A.D. 1900	Internal-combustion engine; electric power.[2]

---

[1]Richard A. Beaumont and Roy B. Helfgott, Management, Automation, and People (Brattleboro, Vermont: The Book Press, 1964), pp. 4-5.

[2]Walter Buckingham, Automation: Its Impact on Business and People (New York: Harper and Brothers Publisher, 1961), p. 1.

In every century since 1650, man has roughly doubled his knowledge of the world. There has been more technological knowledge gained in the last fifty years than in all previous history, and the growth appears to be accelerating.[3]

Time has been telescoped by technology. The gap between theory and invention was fifty to one hundred years in the Renaissance. Now it is more nearly seven years.[4] A century elapsed between Newton's principles and Watt's steam engine, but it took only ten years to go from the A-bomb to the H-bomb. In the past quarter century, the productivity of the average man has doubled. If the same trend continues in the next quarter century, the average family income could go to $14,000 a year instead of the 1963 average of $7,000.[5] This impinges upon vast automatic machines, brought by technological change, capable of extending the physical capabilities of man.

The term "technological change" is an extremely broad term. To better understand it, one should understand its relation to the term "science."

Science is knowledge, formulated to discover general truths; technology is science applied. It has been suggested that "while science is concerned with understanding, technology is concerned with practical uses."[6]

---

[3] Ibid., p. 2.

[4] John Peschon (ed.), Disciplines and Techniques of Systems Control (New York: Blaisdell Publishing Company, 1965), p. vi.

[5] Yale Brozen, Automation: The Impact of Technological Change (Washington: American Enterprise Institute, March, 1963), p. 2.

[6] Buckingham, op. cit., p. 2.

What Is Automation?

The word "automation" was first used in 1946 by D. S. Harder, a vice-president of the Ford Motor Company. He employed it to describe a specific type of machinery. Since then the term has come to be used in a variety of ways and there is much semantic confusion regarding it.[7]

There are two divergent views on automation. One group sees automation as it relates to the use of electronic feedback devices which make machines self-setting and self-correcting. This group refers to automation as a process whereby electronic devices replace human judgment in industry. Those who see automation in this light include John Diebold, president of the Diebold Group of Management Consulting Companies. Mr. Diebold stated before the Subcommittee on Automation and Energy Resources in 1960 that automation meant

> . . . a basic change in production philosophy. . . . a means of organizing or controlling production processes to achieve optimum use of all production resources--mechanical, material and human.[8]

Walter Reuther, testifying before a Congressional committee in 1955, represented this same point of view when he stated:

> Automation makes a completely new development in the technological process because automation, in addition to substituting mechanical power for human power, begins to substitute mechanical judgement for human judgement--the machine begins to substitute the thinking process on a mechanical basis for the thinking process which heretofore was done exclusively by the human mind.[9]

---

[7]Thomas Kennedy and Frank D. Plaut, Automation Funds and Displaced Workers (Boston: Harvard University--Division of Research, Graduate School of Business Administration, 1962), p. 2.

[8]U.S., Congress, Joint Economic Committee, News Views on Automation, 86th Cong., 2nd Sess., Rept. 1152, p. 84.

[9]U.S., Congress, Hearings, Subcommittee on Economic Stabilization of the Joint Committee on the Economic Report, "Automation and Technological Change," 1955, p. 121.

Professor Walter Buckingham implies a similar view when he shows how mechanization (the use of machines to perform work) has been a natural development from changing technology. Automation, however, he sees as a major phase in the advancement of technology. He states:

> Mechanization extended man's muscles; automation extends his brains.[10]

Another authority who takes the similar view that automation is different from earlier technological change is Professor Charles C. Killingsworth of Michigan State University. His views as advanced in 1963 before the United States Senate Committee on Labor and Public Welfare were that

> It is important to distinguish automation from earlier kinds of mechanization, technological change, or economic change, although a great many people use all of these expressions interchangeably. . . . my definition of automation is "the mechanization of sensory, thought, and control processes."[11]

A second group uses the term automation more broadly and looks upon automation as simply an extension of mechanization. This position is expressed by Don G. Mitchell, chairman and president of Sylvania Electric Products. He states:

> . . . Automation is only a more recent term for mechanization which has been going on since the industrial revolution began.[12]

Former Secretary of Labor James P. Mitchell is quoted as saying:

> Automation produces a fear of change. In a technical sense the work represents technological change, which surely is nothing new.[13]

---

[10] Edward L. Cushman, Gerald G. Somers, and Nat Weinberg (eds.), Adjusting to Technological Change (New York: Harper and Row, Publishers, 1963), p. 5.

[11] Charles Markham (ed.), Jobs, Men and Machines: Problems of Automation (New York-London: Frederick A. Praeger, 1964), p. 24.

[12] Kennedy and Plaut, loc. cit.

[13] "Impact of Automation," Monthly Labor Review, Bulletin No. 1287 (November, 1960), 21.

Also included in the second group is Dr. Cledo Bruneti, director of Engineering Research and Development of General Mills, Incorporated, who has said:

> Automation is a newly coined word to describe an old old process. . . . Automation is in truth but a phase of our continuing technological advance.[14]

A third group might use the term still more broadly to describe virtually any change which results in greater productivity per man-hour. This view suggests that the term automation means the application of cost-reducing machines and techniques. Kennedy, in Automation Funds and Displaced Workers, adopts the term automation in this broad sense. He believes that common usage of the term automation in American industry suggests a broad definition.[15] Under such a broad definition, automation is a blanket term which includes any device, however simple, which helps the worker get things done better than previously. Three aspects are usually emphasized when the term automation is used in a broad sense:

1. Getting more done.
2. With less effort and thought.
3. With greater accuracy.[16]

Regardless of which philosophy one accepts for the term automation, there have been distinct steps in automation's development. Laird suggests that the development of automation is roughly analogous to human activities, progressing from simple motor-skill tasks to the

---

[14] Ibid.

[15] Kennedy and Plaut, op. cit., p. 3.

[16] Donald A. Laird and Eleanor C. Laird, How to Get Along with Automation (New York: McGraw-Hill Book Company, 1964), p. 85.

more complex activities of the mind.[17] An illustration of this theory is shown in Table I.

From this chart, it is apparent that the first three divisions are mere extensions of the human being's physical capabilities, i.e., muscle exertion, dexterity, and sensing. Those technological advancements which occurred prior to the twentieth century fall into one of these three categories.

The last three characteristics of automation involve at least a degree of the human being's mental capability. These characteristics such as simple "head work," the capacity for creativeness, and potentially the capacity for social and moral cognizance make automation unique to other technological advancements. These higher senses of automation are accomplished through the use of computers. The computer has become to automation what the human brain is to the body.
Herman A. Simon, Professor of Administration and Associate Dean of Carnegie Institute of Technology, has said:

> A dozen or more computer programs have been written and tested that perform some of the interesting symbol-manipulating, problem-solving tasks that humans can perform and that do so in a manner which simulates, at least in some general respects, the way in which humans do these tasks. Computer programs now play chess and checkers, find proofs for theorems in geometry and logic, compose music, balance assembly lines, design electric motors and generators, memorize nonsense syllables, form concepts, and learn to read.[18]

Computer technology research on new computer designs has created enormous possibilities for future computer applications. One such

---

[17] Ibid.

[18] Martin Greenberger (ed.), Management and the Computer of the Future (New York: M.I.T. Press and John Wiley and Sons, Inc., 1962), pp. 96-97.

TABLE I

AUTOMATION: IN TERMS OF HUMAN ACTIVITIES*

EXAMPLES OF AIDS TO MAN	HUMAN ACTIVITIES		MACHINES THAT REPLACE MAN
Levers, rollers, wheels, pulleys, grease and oil, sharp or handled tools	I	Muscle exertion (Carry, lift, push, turn, walk, bend, squeeze)	Motors, engines, conveyers, horses, wind, water
Tweezers, most hand tools, linotype, sewing machine, typewriter, some jigs, fixtures and assembly lines	II	Dexterity (Hand and finger skill)	Self-feeding, assembly, and transfer machines
Eyeglasses, microscope, amplifiers, stethoscope, indicating gauges, radar	III	Sensing (See, hear, smell, touch, taste)	Photocells, gauges, pressure switches, feedback devices
Tickler file, abacus, slide rule, adding machine, cash register	IV	Simple "head work" (Read, write, figure, remember)	Computers, tape-controlled machines, adding machine, cash register, automatic typewriter
Information, logic, motivation	V	Creativeness (Plan, anticipate, solve problems)	Some computers to some extent
Codes, laws, training	VI	Social, moral (Human relations)	None

*Donald A. Laird and Eleanor C. Laird, How to Get Along with Automation (New York: McGraw-Hill Book Company, 1964), p. 5.

notable achievement occurred in 1961 when the International Business Machines Company developed a computer so versatile that it needed a battery of satellite computers to feed it enough data or information to keep it busy solving problems of business and government.[19]

Feeding data or information to a computer is called programming. In 1947, Dr. John von Neumann of the Institute for Advanced Study at Princeton University devised a way to program a computer for a particular job by merely putting a punched card or tape of instructions into it. This greatly simplified the programming task of computers. The task, however, remains a complex one with punched cards.[20] But it is now thought that it will be possible soon to instruct a computer verbally by means of audio (voice) translation, meaning that conversing with the computer will be simplified still further. This refinement will open still more fields for the intellect of computer-controlled automation.

Each year more computers are brought into worldwide industry. As a result, computer manufacture is extremely profitable in the United States. The year 1967 saw American manufacturers construct and deliver an estimated 11,855 business computer systems, bringing the total built to date in this country to approximately 51,464, valued at some $14 billion dollars. The output in 1967 alone accounts for some $4 billion dollars. Authorities predict an annual 20% growth rate for the data processing industry in general for the next several years.[21]

---

[19]Robert E. Cubbedge, Who Needs People? (Washington: Robert B. Luce, Inc., 1963), p. 7.

[20]Laird and Laird, op. cit., p. 49.

[21]"EDP Boom Keeps Rolling Along," Business Automation, XV (January, 1968), 42.

CHAPTER II

AUTOMATION IN BROADCASTING

A trend toward automation has begun in the broadcasting industry as it has in other industries. The first automatic devices to be employed by the broadcasting industry were transcription changers such as one now may find on home record-playing equipment. The only advantage to such a device was that it played one record after another without an operator's help in placing the stylus or record playback needle in the record groove at the start of each transcription. These machines were inflexible in their application and consequently were not used extensively by the broadcasting industry.

A more important technological advancement used in the broadcasting field was the audio tape recorder. Regarding the development of tape recording, the Ampex Corporation, an outstanding manufacturer of tape recording equipment, reported:

> There is no definite beginning to the history of magnetic recording but we can be certain that credit for building the first magnetic recorder belongs to Valdemar Poulsen. This Danish telephone engineer who is often referred to as the "Father of Magnetic Recording" designed the microphonograph which was an invention of great scientific significance. . . . By using this device a conversation could be permanently recorded for reproduction at any time.
>
> In the early 1900's many scientists were attempting to use magnetic tape in preference to the earlier idea of wire. About 1927 a German inventor named Pfleumer was experimenting with powdered coatings on tape. So far as we know he did not use magnetic oxide but coated his tapes with powdered metallic materials. Development continued and finally about the year 1939 the Germans produced a tape using a durable plastic backing. This began a new era in the

improvement of magnetic tapes, culminating in the superior fidelity we all know.[22]

The transcription changer and tape recorder were classified as automatic machines. But as has been suggested by the chart in Table I, page 7, automatic machines by themselves do not constitute automation. At best, these two technological advances in broadcasting would be classified under "sensing" or "dexterity" machinery on this chart.

Other technological advances have followed the transcription changer and tape recorder. Another notable advancement of recent years was the use of remote control equipment for broadcast transmitters.

Remote Control Controversy

In 1952, the National Association of Broadcasters (NAB) petitioned the Federal Communications Commission (FCC) to relax its rules and regulations relating to remote control of broadcast radio transmitters.[23]

Prior to 1952 all commercial radio stations, regardless of their output power, were required to maintain an FCC licensed operator at the transmitter site every hour the transmitter was on the air. Before 1952, every station had a minimum of two licensed technicians; some stations which were on the air twenty-four hours per day used as many as ten of these license holders.

---

[22]"The Development and Theory of Magnetic Tape Recording," Ampex Manual (October, 1959), 4-10.

[23]This proposal suggested amendment of sections 3.66, 3.274, and 3.572 of the Federal Communications Commission's Rules and Regulations.

In essence, what the NAB proposed in 1952 was that all those stations in the low-to-medium power class (less than 10,000 watts output power) be allowed to operate their transmitters by remote control. Remote control meant that the transmitter could be turned on and off the air and supervised during broadcast hours by studio personnel who might be several miles away from the transmitter site. The remote control principle was not very technically complex. It consisted of an actuator mechanism which responded to electrical commands from the studio. The studio and transmitter were linked together by telephone lines. When the studio unit sent an electrical impulse to the actuator at the transmitter end of the line, the actuator converted the electrical impulse into mechanical energy which turned the broadcast transmitter's main power switch on or off. In addition, various meters could be read at the studio. These corresponded to those meters on the transmitter which monitored the current and voltage values. In terms of Table I, page 7, these remote control systems would be analogous to an extension of the human sensing facilities and a third-stage step toward full automation.

In 1953, the FCC ruled in favor of the 1952 NAB petition, thus giving permission for all small and medium power radio stations to employ remote control of their transmitters.[24]

In 1956, the National Association of Broadcasters again petitioned the FCC. This time, further relaxation of the rules was

---

[24]U.S., Federal Communications Commission, Federal Communications Commission Reports, Decisions and Reports of the Federal Communication Commission of the United States, Washington, D.C., July 12, 1957, to December 27, 1957, Vol. XXIII, Docket No. 10214 (Washington: U.S. Government Printing Office, 1959), p. 458.

requested pertaining to remote control operation of radio transmitters. Pertaining to this petition, the FCC reported the following:

> The Commission has before it for consideration its notice of proposed rulemaking released April 12, 1956 (FCC 56-323) and published in the Federal Register on April 18, 1956, in response to a petition filed by the NAB proposing amendments of the Commission's rules to authorize the remote control operation of all standard and FM broadcast stations.[25]

The 1956 petition requested that the FCC allow any station, whatever its size, the privilege of remote control of its transmitters. This petition included the 50,000-watt clear channel stations and the directional stations. The clear channel stations are those stations which have exclusive use of their broadcast frequencies and are consequently free of interference from other stations. The clear channel stations transmit with the maximum allowable power of 50,000 watts. Directional stations are those which must rely on complex and sensitive phasing devices to control or "beam" their radio signal strength. These directional operations are necessitated wherever stations may interfere with each other.

The technical unions, representing engineering personnel in broadcasting, opposed the FCC adoption of the 1956 petition on technical grounds. The unions were the American Communications Association (ACA), the International Brotherhood of Electrical Workers (IBEW), and the National Association of Broadcast Employees and Technicians (NABET). The unions did not oppose the petition on grounds that such action could cause some union members to lose their jobs. The only mention of economic factors came in one opposing argument by the NABET:

---

[25] Ibid., Docket No. 11677, p. 454.

> The NABET notes that one of the grounds for the decision in docket 10214 [refers to 1953 decision] which authorized remote control for stations with less than 10 kw power and nondirectional antenna was the claim of NAB that relaxation of the rules was necessary so that the small stations could survive in their competitive struggle with the larger stations and argues that the same small station's economic base will be undercut by granting their powerful competitors the same concessions.[26]

In reply to NABET's allegation that a grant of the 1956 proposal would destroy the basis of the 1953 decision, economic assistance to low-power stations, the NAB argued:

> . . . that the major portion of the competition to the small station does not come from the larger station but from other competing media such as newspapers and television and therefore authorization of remote control operations for high-power stations will not materially affect the economic status of the low-power station, and that it is the larger stations that are now feeling the economic pinch.[27]

On September 19, 1957, the FCC ruled in favor of acceptance of the NAB proposal.[28] The only stipulation made by the FCC was that all directional stations and stations with output power over 10,000 watts be considered on an individual basis at the time they would apply for remote control of their respective transmitters.

With the closing of the remote control question in 1957, another automatic device had found a use in the broadcast industry and another basic "seed" of automation had been approved--that of electronic sensing and electronic control.

Automatic Transmitter Logging

In 1960, the National Association of Broadcasters, representing radio station management, petitioned the FCC for a relaxation of Part 3 of the FCC Rules and Regulations. If approved by the FCC, it would allow

---

[26] _Ibid._, p. 458. [27] _Ibid._, p. 460. [28] _Ibid._, p. 454.

radio stations unrestricted use of an automatic device to log transmitter performance.[29]

The automatic logging question pertains to Part 3, section 3.111b of the FCC Rules and Regulations wherein each broadcast station is required to maintain an operation log. The section under consideration states:

> 3.111 Logs. The licensee or permittee of each standard broadcast station shall maintain program and operating logs and shall require entries to be made as follows:
>
> . . . .
>
> (b) In the operating log:
>
> (1) An entry of the time the station begins to supply power to the antenna, and the time it stops.
>
> (2) An entry of the time the program begins and ends.
>
> (3) An entry of each interruption to the carrier wave, its cause, and duration.
>
> (4) An entry of the following each 30 minutes:
>
> (i) Operating constants of last radio stage (total plate current and plate voltage).
>
> (ii) Antenna current.
>
> (iii) Frequency monitor reading.
>
> (5) Any other entries required by the instrument of authorization [station license].[30]

Ordinarily a person must be employed to prepare the operating log. Each half hour the information about the transmitter's operation must be recorded as set forth in section 3.111. Because of the routine nature of such a job, the NAB petition suggested that this job could be done automatically through the use of the automatic logging device. The device would be hooked to the various voltage and current meters on the transmitter and would record on graph paper every movement the meters

---

[29]A. Prose Walker (ed.), NAB Engineering Handbook (New York: McGraw-Hill Book Company, Inc., 1960), Sec. 8-p. 108.

[30]Federal Communications Commission Rules and Regulations, Part 3, section 3.111b.

made during the broadcast day. In the event that the operating voltages were to swing out of operating tolerance, then devices such as lights or buzzers would sound signals calling for human help.

Automatic logging equipment is currently on the market and is gaining widespread use. The FCC amended its rules September 20, 1967, to allow digital meters and print-out devices to be used to monitor operational parameters on broadcast transmitters.[31] Heretofore only conventional analogue-type meters such as might be found monitoring the fuel level in any automobile were used. By contrast, a digital meter would be comparable to those found on a gasoline pump which read out in numerals the number of gallons pumped and amount of money due. The use of digital printout on automatic logging equipment facilitates easier analysis by maintenance personnel and the log data are in a form more compatible with other electronic equipment, such as computers, which might be used to help analyze transmitter performance at an extended period of time.

Program Automation

Simultaneous to the development of the automatic log and remote control equipment, radio as well as television stations have experimented with program automation. For radio station use, program automation essentially consists of pre-recording music to be used on the air and then combining this recorded music automatically with recorded announcements which are produced by the station's staff of announcers. Because

---

[31]"FCC Approves Digital Meters for Transmitters," Broadcast Management/Engineering, III (November, 1967), 8.

the number of routine tasks is reduced, the announcers can have more opportunity to create new program material.

The automatic program switchers have the added advantage of being more accurate in their switching functions than a human being would be day after day. Because of this, the automatic program switchers are able to increase the quality of station programming.

Tape recorders, remote control equipment, and program switchers are automatic devices which are now in general use in the broadcasting industry. By themselves, they do not constitute automation. It may be recalled that Table I, page 7, suggested that in order to have true automation the automatic devices must be integrated and work as an entity much as the human body does, with the brain in control of the physical members of the body and the physical members reporting back to the brain on their execution of commands received from the brain. To so qualify, the broadcasting industry needs control machinery for all of its automatic machines such as the automatic logging equipment. For this reason, computers are beginning to enter the broadcast field. This is particularly true in the areas of accounting, program scheduling, and audience research. Computer applications for radio and television station use are described in Chapters IV, V, and VI of this thesis.

Employment Problems Created by Automation

The introduction of automation has created much concern over its possible effects on employment. As in all controversy, there are two sides to be considered. On one side of the dispute stands organized labor. On the opposite side is industrial management. Sandwiched between these opposing forces are economists, government committees, and

agencies who busily analyze the ever-changing economic picture of the United States economy and assist in the solution of those disputes which arise from the unrest which surrounds the advance of automation.

The Joint Economic Committee of Congress, in its analysis of the unemployment situation between 1957 and 1960, explained that higher unemployment rates during this period revolved around two major theoretical approaches--the aggregate demand theory and the structural transformation theory.

The aggregate demand theory maintained that:

> The unemployment rate has been quite high since mid-1957 because the rate of growth in final demand [of finished products] has been low relative to the actual and normal rates of growth in potential supply made possible by increases in capital stock, labor force, and productivity.[32]

In other words, according to this theory the unemployment problem could be solved by the economic growth of the country and the economic demand for the finished products.

> . . . higher employment has been due not to inadequate final demand . . . but rather to technological changes which are currently reshaping the American economy at an unusually rapid pace.[33]

Industrial management seems to favor the aggregate demand theory, while organized labor tends to support the structural transformation theory. The government-sponsored Joint Economic Committee concluded in 1960 that there was not enough evidence for the structural theory and recommended the aggregate demand theory instead.[34] The President's

---

[32]Richard A. Beaumont and Roy B. Helfgott, Management, Automation, and People (Brattleboro, Vermont: The Book Press, 1964), p. 22.

[33]Ibid. [34]Ibid.

Council of Economic Advisors also favored the aggregate demand theory. Their analysis of the unemployment problem, using the aggregate demand theory that unemployment is caused primarily by a lagging growth rate, became a basis for President Lyndon B. Johnson's emphasis on a large tax cut as the top priority item in a program to stimulate the economy.[35] The Johnson Administration won support of the tax cut measure. Thus, in effect, government ruled in favor of the aggregate demand theory as a measure to slow unemployment.

Between 1960 and 1965, unemployment went into a decline. Business Automation editorialized in 1965:

> The Bureau of Labor Statistics reports that since the first quarter of 1961, four million jobs have been added to the national economy, while the number of unemployed persons declined by one million. . . . The BLS finds that the nation's unemployment rate had dropped from a May, 1961, figure of 7.1% to a level of 5.1% in November of 1964.[36]

In spite of statistics, organized labor upholds the structural transformation theory that technological change is to blame for unemployment. Professor Charles Killingsworth agrees that there is credence in this theory. He states that "automation, particularly in its more advanced form [computer-controlled], fundamentally changes the man-machine relationship."[37] He believes that advanced automation has two major results in the job market. The first result is a reduction in the number of simple, repetitive jobs where all that is required are five

---

[35]Charles Markham (ed.), Jobs, Men, and Machines: Problems of Automation (New York: Frederick A. Praeger, 1964), p. 36.

[36]Richard D. Kornblum, (Editorial), Business Automation, XII (March, 1965), 76.

[37]Markham (ed.), op. cit., p. 88.

senses and an untrained mind. The second result is an increase in the number of jobs that are concerned with designing, engineering, and administering automatic production systems. Killingsworth substantiates this shift in the labor structure in the following quotation:

> Between 1957 and 1962, nonproduction workers, a somewhat unflattering way of referring to white-collar workers in industry, increased by about a third of a million, while production workers decreased by nearly a million. The net result was an over-all decrease of about 600,000 in total employment in manufacturing.[38]

Professor Killingsworth concluded that when the effects of automation and the effects of this change in consumer spending are combined, the result is a tremendous increase in the demand for highly skilled people and a reduction in the demand for relatively unskilled people. In an economy where so many patterns are changing rapidly, statistics which "show broad averages and grand totals may conceal more than they reveal,"[39] according to Professor Killingsworth.

Similarly, since 1960 the National Association of Broadcast Employees and Technicians Union has carried its case to the Federal Communications Commission. In its argument, NABET has cited the personnel problems caused by automation in the industry. It was reported that from 1955 to 1962 there was a 15% reduction of technicians in the employ of the broadcast industry because of automation.[40]

In summary, there are two opposing viewpoints as to the basic cause of unemployment. Industrial management, using the aggregate

---

[38] Ibid., p. 34.

[39] Ibid., p. 34.

[40] "How Good Is Automated Radio?" Sponsor/U.S. Radio (March 26, 1962), 66.

demand theory, suggests that unemployment stems from slow nation-wide economic growth. Organized labor upholds the structural transformation theory which suggests that technological change is a basis of unemployment. Both sides have presented convincing evidence as to the validity of each of the theories.

Pace of Broadcast Automation

A survey made by Sponsor/U.S. Radio magazine in 1962 indicated that the trend toward automation in the broadcast industry had been slow.[41]

The speed with which automation moves into any industry depends on two factors, according to Brozen. In a research article written for the American Enterprise Institute, he stated:

> How rapidly we [industry] automate depends upon the availability of capital and the rapidity of the rise in real wage rates.[42]

If the broadcast industry is analyzed on the basis of these two criteria as suggested by Brozen, the relatively slow-paced advancement of automation into the broadcasting industry is more understandable.

Availability of Capital

It is natural that the larger corporation has more capital available which can be used for experimentation with automation than does the small company. However, the maximum corporate size which is allowed

---

[41]Ibid., p. 65.

[42]Yale Brozen, Automation: The Impact of Technological Change (Washington: American Enterprise Institute, 1963), p. 3.

in the broadcast industry is closely guarded by federal supervision. To preserve competition in radio and television, the FCC is directed by law not to grant licenses to applicants when, by doing so, competition would be substantially reduced or commerce restrained. The Commission has ruled that not more than one AM, one FM, and one TV station serving the same listening area may be licensed to the same applicant. This is known as the "duopoly" rule. No more than seven AM, seven FM, and seven TV (five VHF and two UHF) stations serving different areas may be licensed to or controlled by the same persons or corporations. This limitation has been challenged in federal court. In 1955, the Storer Broadcasting Company challenged the limitation, but the court allowed the limitation to stand.[43]

Because of the duopoly rule, an inherent limitation is imposed on industrial consolidation and consequently on the amount of capital which is available for experimentation with automation. Availability of capital, however, is not the only factor which controls the pace with which automation moves into industry. The rapidity of the rise in real wage rates must be considered also.

<u>Automation's Pace as Related to Wage Rates</u>

According to the American Enterprise Institute, increases in wage rates make it economically feasible to automate when it otherwise would not be.

> The cost of the new equipment required to replace a man is about $35,000. If the annual wage of a man is less than $7,000, it does not pay to replace him at this cost since property and corporate

---

[43]Giraud Chester and Garnet R. Garrison, <u>Television and Radio</u> (New York: Appleton-Century-Crofts, Inc., 1956), p. 73.

earnings taxes, insurance, depreciation and interest costs amount to about $7,000 on $35,000 worth of equipment. If annual employment costs rise above $7,000, it then pays to replace a few men.[44]

From the above statement it can be construed that the proximity of annual employment costs to the $7,000 level should serve as a crude barometer which might indicate the speed with which automation could be adopted by an industry. Therefore, by comparing annual employment costs of broadcast employees to the approximated $7,000 dividing line, an indicator as to how rapidly automation might be adopted by the broadcast industry can be demonstrated.

Below are listed employment cost statistics on broadcast employees, 1963 through 1966.

TABLE II

WEEKLY AND YEARLY WAGES OF NON-SUPERVISORY BROADCAST EMPLOYEES*

Year	Weekly Average	Yearly Average
1963	$133.96	$6,965.92
1964	140.66	7,314.32
1965	147.63	7,676.76
1966	151.24	7,864.48

*U.S., Bureau of Labor Statistics, Employment and Earnings Statistics for United States, 1909-1967, Bulletin No. 1312-5 (October, 1967), 677.

According to these statistics on broadcast employees (which are available in Statistical Abstract), it is evident that neither the wage

[44]Brozen, op. cit., p. 5.

level nor the rate of wage increase has been sufficient to force broadcasters into a great deal of rapid automation. As Table II shows, the average yearly salary of non-supervisory broadcast employees is increasing each year. According to these statistics, the average yearly salary of the non-supervisory employee has crossed the $7,000 per year wage borderline which was suggested by Brozen as the dividing line between the slow advancement or the fast advancement of automation.[45] Now that the non-supervisory broadcast employee average wage has attained and surpassed the $7,000 point, presumably, the broadcast industry may experience larger strides toward automation. However, in the intervening years since the 1963 Brozen study, inflation and other economic factors have undoubtedly pushed the borderline beyond the $7,000 point.

---

[45] Brozen, loc. cit.

CHAPTER III

RADIO PROGRAM AUTOMATION

As has been suggested in the preceding chapter, radio program automation essentially consists of pre-recording music or program segments to be used on the air and then combining these program features with the recorded announcements which are produced by the station's staff of announcers. The motivation factor behind radio program automation stems from the fact that a large part of radio programming is repetitious. Music, music introductions, program introductions, and commercial announcements are all repetitive types of material which occur again and again, day after day, and constitute the bulk of radio programming. If this bulk program material is committed to recording tape and these tapes arranged to be switched on and off the air at the proper time by automatic equipment, this is, in its simplest state, automated radio.

The usefulness of radio program automation depends upon the ratio of repetitive material to the material which must be changed constantly. In other words, it takes three to four times more production time to prepare program segments for automated program equipment than it does to do the same segment live. Consequently, if this program segment cannot be aired at least five or more times, then program automation is a poor investment in production time.

Some program material exists which cannot be automated. Telephone audience participation programs and any other material of extremely

current nature are examples of program forms that must be broadcast live.

There are certain alternatives, however, that will permit some stations to take advantage of automation even though some of the programming is not adaptable to automated operation. Station personnel from departments other than production may be available to physically program current material into an automation system. An example may be found in the news department, where the newsman may take the responsibility of seeing that two newscasts are recorded and inserted twice each hour. A second alternative is a rearrangement of the program schedule to accommodate block programming of live productions into a unified segment, leaving the balance of the day's broadcasting to be done through automated means. The significant factor is to recognise a new philosophy of program preparation and, by careful analysis, determine whether this approach to radio programming will improve any specific station operation.

In the modern radio station, the separation of duties between the engineer and the program director becomes increasingly obsolete when modern broadcast automation is introduced. No longer can management turn to the engineering department alone for a decision as to what type of broadcasting equipment is best for the station. The automatic equipment which is purchased must meet good programming standards as well as be desirable from the engineer's technical point of view. Thus programming and engineering decisions must go hand-in-hand.

The roots of modern broadcast automation go back to the days when musicians were widely used by radio stations to produce live music in the

radio studios. As time passed, the radio broadcaster discovered that phonograph records of the musicians' performances could be used much more cheaply than could live performances by the musicians. This trend evolved into what might be called the "disc jockey" era, wherein a live staff announcer plays recorded music and provides comments between selections. Thereby, a relatively inexpensive program is created which is acceptable to the audience.

Present day audio automation carries the advancement one step further. Disc recordings are themselves replaced by taped music. The live announcer also gives way to the taped announcer. In fact, the term "live announcer" is fast becoming a misnomer even in stations which consider themselves "live." Indeed, there sits the announcer at his console in front of the microphone. Yet, with the widespread use of cartridges or other pre-recorded means to deliver station identifications, promotions, and commercials, to say nothing of the music itself, the "live" announcer is often little more than a button pusher. The way is now open to the most significant advances in broadcast automation equipment--audio switching.

Audio Switching Methods

Audio switching is the heart of all automated radio programming. Because audio switching is the stratum upon which the whole of program automation exists, the means by which it is accomplished should be investigated further.

To produce even the simplest radio programs, a certain amount of audio switching must be done. If the program which is being broadcast

employs a solo speaker, then only one switch need be turned on--his microphone switch. If the solo speaker plans to use recorded music during the program, then another switch must be thrown, that of either the phonograph turntable or the tape recorder. In a modern "disc jockey" program, where phonograph record after record is interspersed by tape recorded and live announcements, a large amount of audio switching is necessary to produce such a program hour after hour. Equipment can be constructed which will do all of this switching--automatically. By furnishing hidden signals or cues to the automatic equipment, all audio switching can be accomplished as if a human being were doing the job.

In reviewing and analyzing various approaches to audio switching methods, it must be remembered that the task to be accomplished in each case is the placing of a signal, or cue of some sort, at the end of each unit of programming. This cue is used to start the next scheduled unit of programming. In the past, many methods have been employed. The following have been most notable.

Metal Paint or Foil

Probably the simplest system of switching makes use of either metal paint or metal foil on audio tape. As the audio tape passes over the contacts a circuit is closed and the switch is accomplished. It is impractical, however, to switch at the end of each unit of programming on a reel of tape using metal foil due to the time involved in putting on each piece of metal tape.

End of Tape or Record

Most home-type record changers start their end-of-record cycle at a particular place on the recording--usually at the very end of the

record which has just finished playing. This system might be used to start the next sequence in automation systems. Reel-to-reel tape machines could use the same system. When a reel of tape completes its run, the "tape break" switches could start the next operation. This system is quite cumbersome and is not very practical in actual daily operation. Once the tape runs completely through the machine it must be rethreaded to be used again.

Light-Sensitive Devices

Photo cells are used in various configurations. With audio tape, the oxide is removed at the switching point and light is allowed to pass through the transparent backing of the audio tape to the photo cell. This system has proved quite successful except for the occasional oxide breaks that inadvertently appear in the tape, giving out a false switching pulse.

Time Switching

Time switching is used in most automation systems at some point or another. This might be used to switch to a network, remote, or other operation by use of a repetitive timer or clock, or it could be used to "ready" a switching action while the actual switching is accomplished by other means. All complex automation systems use a timer or clock for correction so that operators are freed of the burden of timing each segment.

Silence Switching

In the past, silence has been used extensively for switching. It is one of the simplest systems as far as "make-up" is concerned. The

operator has but to leave a silent spot in the recording. It is about the only practical method when individual phonograph records are used in a system. It has serious disadvantages, however, since silence is a negative device rather than a positive one. If silence is advertently left in the middle of a unit of programming, pre-switching can occur. The classic example is the recording of a "cha-cha-cha" which may have long spaces of silence between beats of the music. Also, silence is a relative thing. Surface noise, tape hiss, tube noise, and other types of non-intelligible audio can ruin a period of what should be silence. For these reasons, silence has been largely abandoned as a means of switching and is used only for fail-safe purposes in modern systems. This means that if the automatic equipment senses a long period of silence, such as might be caused from tape breakage or equipment failure, then the automatic switcher will switch on another playback machine which is operable.

Tone Switching

Presently the most reliable system of switching is with tones. In essence, tone switching amounts to nothing more than superimposing a low frequency tone on the tape at the place where switching is desired, such as at the end of a musical selection or voice announcement. Some manufacturers have standardized on 30 cycles because it is easy to compare to a 60-cycle AC line for tone accuracy. Other systems use 25 cycles, which is much harder to check for frequency accuracy. (Official NAB recognition of this unofficial standard would be of benefit to the industry in making automation systems and music services compatible.)

Standards have already been set on cartridge equipment.[46]

There are two basic methods of tone switching. The first is a subaudible tone mixed with the program material. This method works quite well if care is taken to insure that regular audio does not contain tones at the switching frequency which would cause false switching. An example might be a pipe organ solo which might contain low notes having undertones extending to and below 25 cycles. If the automation senses these tones, then false switching could occur. This problem can be eliminated by the use of appropriate filters. Care must be taken, also, to insure that the ratio between the level of the switching tone and the maximum recording level is consistent.

The second method of tone switching is to use a separate or cue track for switching tones. This method is most common on cartridge equipment. This development results in increased reliability as the sensing unit need listen only to the cue track, not the program audio. The problems of level, distortion, and low frequency tones prevalent in the program track system are greatly reduced. Also, a multitude of frequencies and configurations within the audio range (20-20,000) are possible since they do not go on the air.

Summary

Some type of cue must be given to automatic switching systems in order for them to know when to perform a switching action. Six methods have been listed: metal paint or foil, end of tape or record, light-

---

[46]Danny Coulthurst, "Broadcast Automation--Past, Present, and Future," A Report to the 1965 NAB Broadcast Engineering Conference, March 21 to March 24, 1965, Washington, D. C., p. 3. (Mimeographed.)

sensitive devices, time switching, silence switching, and tone switching.

Metal paint or foil and light-sensitive devices are difficult to apply and difficult to erase. The end of tape switching method is too awkward for automated system use since an operator would have to rethread the tape after each use. Time switching is useful in limited application as in starting precisely scheduled events such as network programs. Silence switching is a negative type of switching and is used more to indicate equipment failure than a positive switching command. Of all the methods listed, tone switching is the most versatile. Tone switching is more reliable than silence because it is positive and it is easier to apply and erase than are metal foil and light-sensitive devices.

Program Control Methods

There are two basic approaches to program control: the sequential approach and the insertion approach. In the following explanation, at least one word should be defined. Systems commonly have two or more transports or channels. It is therefore necessary to standardize on the word "channel" to mean a program playback unit of any type such as a reel-to-reel playback machine filled with pre-recorded music, or a cartridge playback, or a network line.

Sequential Systems

The simplest sequential system might be called a "flip-flop." Here only two channels are used and they alternate from #1 to #2 at each switching tone. Because of its simplicity, the "flip-flop" system is

reliable and easy to operate. Its simplicity, however, severely limits its flexibility and it is used only in the simplest of applications. To increase flexibility, additional channels must be added. The simplest method of controlling multiple channels would be to set up a sequence either on switches or on a patch panel. Once established, the order remains fixed until manually changed. Thus channel 2 is on the air after channel 1; channel 3 follows channel 2, etc. By adding a timer clock, the sequence can be reset to again start with channel 1 after a given length of time.[47]

There are advantages in the use of the sequential system. It is quite easily understood by operators and maintenance personnel. Also, the operator always knows the exact order in which channels are sequenced and therefore which features will be played next.

There is a major disadvantage in the sequential system. Once set, the sequence never varies until manually changed. Most broadcasters feel this leads to a "canned" sound. If this is to be avoided, the sequence must be changed often, i.e., instead of a 1-2-3 order one might want a 2-1-3 order. This, in turn, means that an operator must be on duty to manually change the sequence. Having to keep an operator on duty to accomplish such a menial task would lessen the economic advantage of the system.

<u>Insertion System</u>

In this system, a single music channel is used, generally containing all music and music introductions. This music becomes "home

---

[47]Thomas R. Hasket, "Audio Tape Equipment," <u>Broadcast Engineering</u> (February, 1965), 18.

base" and non-music features are inserted between musical selections. Other programming features are loaded into the appropriate channels, or machines, each of which has a selector to permit it to be inserted on a time base as determined by a master clock. This time base may be repetitive, such as every 5 minutes, every 15 minutes, or longer as the break times may dictate. Where multiple channels are used, a simple priority is established whereby the most important channel will be inserted first, followed by the second most important channel, and so on. When no other channel is ready, the music channel will fill in.[48]

The main disadvantage of the insertion system is that music must be pre-programmed. Once recorded, the programming balance and mix cannot be changed without re-recording because all of the music selections are on one extended length tape. Repetition of music tapes can be a problem unless enough tapes are provided. Most stations using an insertion system would probably look to an outside music recording service to supply many or perhaps all of their tapes.

Random Select System

The random select system is the most versatile system now on the market but it is generally more complex. In the random select system, any channel can follow any other channel in an ever-changing pattern. There are four basic types of memory storage used in random select systems: (1) audio tape, (2) program log paper, (3) punched paper tape, and (4) punched data cards.

---

[48]Coulthurst, *op. cit.*

At least one major company uses tones or sequences of tones recorded on an audio tape to store the sequence of events for the day. In this type of system, the operator sets up the sequence for the next hour of programming by dialing the numbers of various program sources in order as they are to occur. Each channel or tape playback machine is given a tone code. Each time the operator dials this code the code is recorded on the system programmer's internal tape. If the operator dials 1-2-3, then when the system programmer plays back this information it starts machine 1 first, then 2, and so on in the exact sequence as recorded. One seven-minute cartridge can store all of the sequences needed for a full week of programming. The main difficulty in the use of this system lies in the necessity of having to erase all of the sequence information for the week simply to correct one mistake. Further advances on the programmer design may reduce the faults on this system to a minimum.[49]

Another company, Continental Electronics Company, in its prolog system, uses a specially prepared program log to establish the channel sequence. An IBM machine codes the log paper. This may be done manually. The log paper, in turn, is loaded into a "reading" machine and the log moves through this machine, scheduling the various channels. Authentication of the log is done automatically by a clockprinter which shows year, month, date, and time. Prolog claims the unit to be accurate plus or minus one second on each entry made. In the event a

---

[49]Planning for Automated Radio Programming, A Report prepared by the Automatic Tape Control to the 1965 NAB Broadcast Engineering Conference, March 21-24, 1965, Washington, D. C., p. 10.

correction must be made in the program log, the operator must locate that portion of the log and erase the machine code. Photocells read the log sequence information in much the same manner as do automatic test grading devices which are used by educators. Instead of a student's placing a black pencil mark in a designated area for a correct test answer, the station secretary can place strategic black marks on the log, thereby setting up the program sequence.[50]

The main disadvantage of any of the aforementioned systems, however, is the difficulty with which changes are made. Each system, as has been pointed out, has its own solution; but extensive changes are cumbersome at best. Both the audio tape and the punched paper tape must be redone, often in their entirety. The program log paper must be corrected whenever last minute changes are necessary.[51] There is one method by which the job can be accomplished in a much more expedient manner. This method involves the use of punched cards.

Originally, punched cards were used to make up radio and television logs and for billing purposes. Recently, several companies have developed automatic control systems designed around card readers. These readers are manufactured by the National Cash Register Company and by IBM. In its simplest form, each data card represents a particular channel such as reel-to-reel or cartridge machine. Cards are stacked manually in the desired order and loaded into the reader. The reader

---

[50]"Prolog" Automatic Programming and Logging for AM or FM, A Report by the LVT Continental Electronic Division of Ling-Temco-Vought, Inc., to the 1965 NAB Broadcast Engineering Conference, March 21-24, 1965, Washington, D. C., pp. 3-7.

[51]Coulthurst, op. cit., p. 12.

itself programs the order of the features as each card is brought to the reader head. The sequence can be changed at any time by simply changing the order of the cards. Key punching equipment can be used to punch an alpha-numeric description of each feature into the card itself. All information necessary for traffic, the program log, accounting, and billing goes on a single card. Card-sorting equipment can then be used to sort the cards into their proper sequence. At this point, the card reader takes over and programs the various audio sources in their proper order. As each audio source is put on the air, an electric typewriter types the program log, taking the accurate time from a digital clock and the program feature description from the card itself. The commercial cards can then be stored until the end of the month when they are used for billing and accounting on the appropriate accounting equipment.[52]

This system is most versatile in that changes can be made easily right up to the last minute before air time. The system can be used with a program service designed for an insertion system or with multiple music transports as in a sequential system. Each program feature is properly logged only when it has actually gone on the air. The tie-in with traffic, logging, accounting, and billing also permits a fully integrated system with appropriate long-range cost savings in all departments of the station. The ultimate in radio program automation lies in the card controlled random select switcher.

Because of the complexity of the card-controlled systems and the true flexibility offered by them, it will be necessary to go into

---

[52] Ibid., pp. 12-13.

operational detail in order to understand how the modern broadcast plant can benefit most from the systems' distinct features.

As already mentioned, the heart of the card-controlled random sequential system is the punched card reader. This compact unit stores up to 500 cards, each representing a different element of the daily program schedule. The reader tells which channel or transport is to go on the air next by transmitting the code in the fourth column of the card to a switch module which controls the channel. (See Figure 1.)[53]

The program features themselves, such as music, commercials, and news, are pre-recorded on reel-to-reel player transports or on cartridge tape players. Each player unit represents a channel and that player or channel is arbitrarily assigned a code number. (See Figure 1.)

The pre-punched cards containing the proper channel designations are then stacked in the order in which the features are to go on the air and loaded into the card reader for a trial run-through.

During the trial run-through of the cards, the card reader is monitored by the automatic typewriter printout. This trial run-through takes approximately 15 minutes to produce the preliminary log or pre-play log for an entire 24-hour broadcast day. The preliminary log is distributed throughout the station to the various departments involved in the airing of the daily program--traffic, programming, and engineering. (See Figure 1 for an example of a pre-play log.) When all departments are in agreement and the pre-play log has been corrected, the

---

[53] "Visual 12,000 Audio Automation with IBM Punch Card Control," A Technical Paper prepared by the Visual Electronics Corporation for the 1965 NAB Broadcast Engineering Conference, March 21-24, 1965, Washington, D. C., p. 2.

Fig. 1.--Diagram of data card and program logs

1. The machine position number tells the card reader which tape playback machine to start next. An example of this is where the digits 002 are assigned to the cartridge playback machine which contains only commercial announcements. If the digits 002 are punched into a card then the playback machine containing commercial announcements will be the only machine started, once the card has been mechanically read by the card reader.

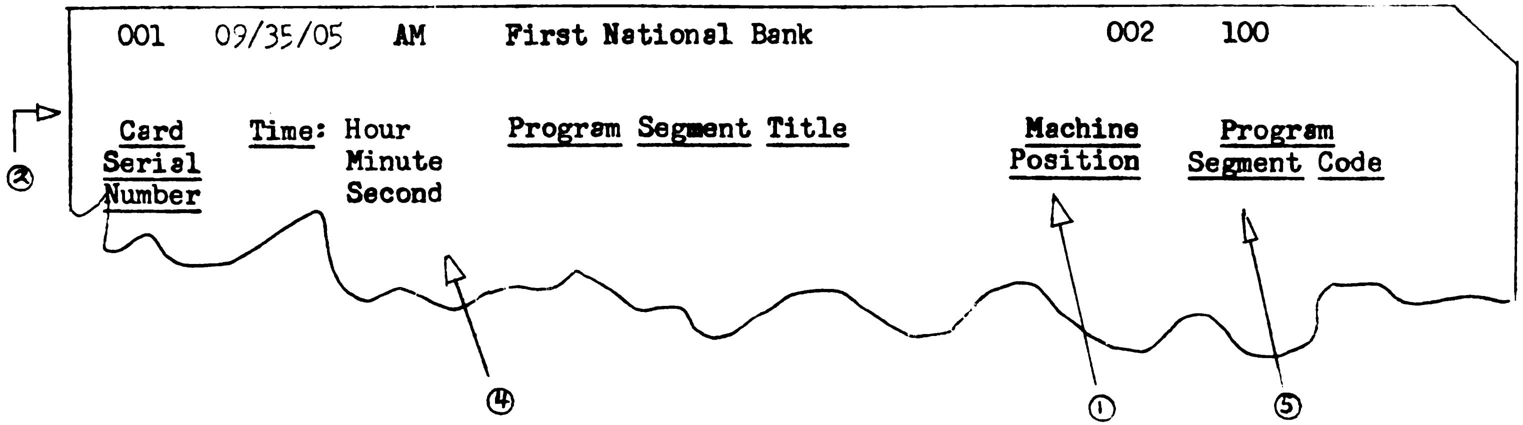
2. Illustrated is a typical "commercial announcement" card. All of the data typed on the card face are also "punched" into the card body to facilitate machine reading by the card reader. A "music" card or a card which starts the proper music playback machine is similar in appearance but contains less data. For practical operation, the music card need only contain the machine position number.

3. To simplify make-up of music tapes, only the "end of segment" tones are added at the conclusion of each music number. Therefore the verification column of the preplay log is left blank. If the automatic typewriter printout does not receive a tone burst from the musical selection, then it cannot verify its playing on the air. The music tapes do not have verification burst recorded on them; consequently, no verification is possible when they go on the air.

4. Each card has typed on it a suggested on-air time. This suggested time is automatically typed on both the preplay log and the final program log under the column listed as "time." The true or actual on-air time is found in the "time stamp" column. The official true on-air time is automatically stamped on the log at the beginning of each new segment.

5. The digits contained in the "program segment code" column of the logs and on the card exist to provide a verification reference. In the above illustration, the digits 100 are punched into the card to enable the typewriter printout to type these numbers on the two log sheets. When the "First National Bk." commercial was recorded, the digits 100 were also contained on the tape in the form of tone bursts. Thus at the time the final log is being typed the automatic typewriter receives the digits 100 first from the card. These are logged in the "Prg Code" column. Later, the digits 100 are received from the audio tape in the form of tone bursts. These are logged in the "Verification" column. If both columns agree in number, then this constitutes verification.

Data Card



IBM Automatically Typed Preplay Log for Checking and Correcting

Time Stamp	Card No.	Time	Program Segment	Machine Position	Program Code	Verification
	001	09/35/05	First National Bank	002	100	
	002	09/36/08	Station Promo	001	105	
	865	09/36/50	Music	003	000	
	866	09/38/30	Music	004	000	
	069	09/40/40	Helen's Flowers	002	101	

Automatically Typed Final Log Printed at Time of Take

Time Stamp	Card No.	Time	Program Segment	Machine Position	Program Code	Verification
July 9 9:35:10	001	09/35/05	First National Bank	002	100	100
July 9 9:36:12	002	09/36/08	Station Promo	001	105	105
July 9 9:37:00	865	09/36/50	Music	003	000	
July 9 9:39:26	866	09/38/30	Music	004	000	
July 9 9:41:06	069	09/40/40	Helen's Flowers	002	101	101
July 9 9:41:36	022	09/41/10	Story Olds	005	130	130

Fig. 1.--Diagram of data card and program logs

various program channels are then loaded in accordance with the log and the card reader is now set to start its on-the-air switching of the various audio channels. The stack of data cards is loaded into the reader, the proper start button is pressed, and thus begins the automated program.[54]

The automated typewriter printout is now switched over to monitor the actual on-the-air program, and as it does so it proceeds to make a typed final program log. The log entries are made at the exact time the program segments go on the air.[55]

By reading the combination of perforated holes in each card, the card reader knows exactly which machine to switch on the air next. At the end of each audio segment, the low frequency 25-cycle tone recorded on the taped program tells the card reader when that segment of audio is over and when to switch to another. Various tone filters are employed to make certain that only the automated equipment hears these low frequency switching tones and that the listener at home does not hear them. In other words, the low frequency tones are filtered out long before the program arrives at the input of the transmitter.

Any system which prepares the final program log automatically presents a verification problem. First, the station must have proof that the proper program segment is aired at the scheduled time, and second, the verification system must adhere to FCC guidelines. These two demands necessitate a foolproof and fail-safe system of verification.

---

[54] Ibid., p. 2. [55] Ibid.

The card-controlled system presents a rather unique but complex solution to verification. To understand how the verification is accomplished automatically, it is necessary to first review how the program segments are "made up" on tape. It has previously been explained that at the conclusion of each program segment, whether it be a taped musical selection or a taped commercial, all segments must have a low frequency 25-cycle switching tone. This tone is the cue which makes the card reader switch to the next segment. Through a similar process of "hidden" tones, automatic verification becomes a reality.

By putting the series of tone bursts on the start of each tape at the time the audio message is being recorded, in effect each commercial announcement is given its personal identification. These tone bursts (3-digit) are varied so that no commercial has the same number or kind of bursts. As each cartridge or program source is played on the air, identifying code tones are fed back through the tone recovery encoder and are printed out as verification in the log verification column. At the time the tones are first sensed by the playback machine, the automatic typewriter printout gives the year, date, and time plus or minus one second that the tone burst is heard. Later, the typewriter types in the identifying code number derived from the tone burst. This code number should correspond with the number printed on the data card. The data card has this same identification number punched into it. Therefore, the identification number is typed out twice, once from the information read from the punched card and once from the tone bursts on the recorded program segment. If the numbers correspond, then the proper program segment was put on the air in conjunction with its

respective data card. (See Figure 1.) When the switcher or card reader hears the end of the segment tone, the automatic typewriter logs the official off-time for that announcement.

Detailed Description of System's Components

Data Cards

Physically, the cards may be either of cardboard or plastic. The plastic impregnated variety are not subject to normal requirements of temperature and humidity. Normally, they may be used 75 to 100 times without card damage which could cause feeding or reading errors. Figure 1 shows the individual serial number for each card. In actual on-the-air switching, this number has little value. The serial number is useful only to the personnel in traffic, whose duty it is to catalogue each individual card for such purposes as billing, sales commissions, and spot availabilities.

The second column shows time--hour, minute, and second--with the letter "A" for A.M. and "P" for P.M. Again, this information is used primarily in the traffic department when the initial stacking of cards takes place. This time is only a suggested time. An example would be in making up a client's schedule. Say that sponser John Doe buys 36 one-minute spots for a one-week period and suggests a schedule of six spots per day, spaced at four-hour intervals. The key punch operator and card typist will prepare six different cards, with the suggested run times on the cards. These same six cards may be used day after day until the expiration of the 36-spot contract. The time mark on the card, then, is designed as an aid for the personnel who stack the program cards for the day's sequence of events.

The "program segment" listed in the third column of the card is self explanatory. Again, this information is used only by those who are in charge of placing the cards in the proper order for on-the-air use.

In the fifth column, the machine channel is listed. Not only is this information typed on the card, but these data must be punched into the card for the card reader's benefit. This punched code on each card dictates to the card reader which music or announce channel is to be switched on the air next. An example of this occurs in a station where all of each day's commercial announcements are on one continuous reel of tape. This tape player may be arbitrarily assigned 011 as its channel number. Assuming that the spot announcements have been dubbed or recorded on the tape in the same sequence as the cards are stacked, then all the key punch operator need do is punch a code number 011 onto all cards which are recorded on the master commercial tape.

Key Punch-Card Reader

The key punch combination card reader doubles in duty by functioning as both the machine on which each card is punched, then later read. As each card is machine read, the punched holes in the respective cards cause the reading unit to select the desired program channel.

Automatic Typewriter Printout

The typewriter printout serves as the official link between the functions of man and machine. The automatic printout, which operates much as a news teletype machine, is useful in determining whether the cards are in the proper order by first building a preliminary log. This log is checked for mistakes and is used to load the commercial tape and

the music channels in sequence. Later when the on-the-air period of switching starts, the automatic typewriter begins to build the official program log as each program segments goes on the air.

Another added feature of the automatic typewriter is the automatic time stamp which is integrated into the typing mechanism. At the start of each program unit this stamp signifies the date, year, and time to the second. This same stamp gives the exact time the program segment leaves the air, in accordance with FCC ruling. Both the key punch-card reader and automatic typewriter printout are included in the standard card system. The IBM 836 card punch and reader and the IBM 866 typewriter may be used as a complete system or may be integrated with other card sorters and tabulation equipment.[56] This aspect will be discussed later in the section which deals with automatic billing equipment. It should be recalled, however, that IBM is not the only source of automatic card handling equipment. National Cash Register Company is another organization which builds suitable equipment for automation control. In the event that sufficient technical personnel are not available for servicing of such equipment, renting might be advantageous.

Make-up of Special Automation Tapes

The secret to the success of any automatic switcher lies in the cautious placing of cue tones on the various program segments. The switching tones needed for the complex "random card switcher" are much the same as those which are used in the simpler automation switchers. A

---

[56]"Visual 12,000 Audio Automation with IBM Punch Card Control," p. 4.

25-cycle tone of one or more seconds in duration is used at the end of each segment. The "make-up" announcers or operators must be certain this tone is energized at just the right moment, otherwise a glaring production error can exist. If the tone occurs too late, then there will be "dead air" between musical selections, commercial announcements, or whichever segments might happen to be on the air. Announcers and engineers with a degree of aesthetic talent will soon discover the importance of tone placement; after a few weeks of experimentation they can have the automated program moving with the tempo which a good "tight" live show should have.

As has been explained, all of the music usually comes from reel-to-reel tape transports. Most spot announcements, such as commercials or public service announcements, are recorded on cartridge machines. The rationale supporting the use of cartridge machines stems from the mobility of the machine. Once the commercial is contained on a separate cartridge, it may be pulled out easily from the automation for live show use or it may be erased and changed without disturbing the program segments. Each commercial cartridge is a composite of three types of information. The order in which they occur on the cartridge are:

1. the verification tone bursts,
2. the audio message or commercial announcement proper, and
3. the switching tone which signifies the end of the audio track.

The audio track or announcement is self explanatory in as much as this is what the audience hears in the radio receiving sets. The end of the message has already been discussed at length. The verification code

pulses remain as the only tones or data found on the cartridge which have not been explained.

The Federal Communications Commission has set up broad guidelines in verification procedures which must be used when stations log daily programming. This implies that some kind of accurate means must be established whereby the actual time on the air of commercial announcements is logged. This is accomplished by the automatic time stamp or the typewriter printout. But as a fail-safe procedure, and to be sure that the proper commercial was aired when the program log indicates it was, it is necessary to record special tone pulses on the cartridge when it is being "made-up" by the announcer. This is in effect the same as assigning each cartridge an electronic serial number. Since each cartridge recorder is dual-track, this verification tone burst along with the end of the message cue are recorded on a separate track from the audio message. In other words, only the machine can sense these tones. When the cartridge has been recorded and is played back through the card reader and monitored by the automatic typewriter, the verification tones will be sensed and will agree with the program code number. The program code number is contained on the data card and is read by the card reader. On the other hand, the verification number on the log comes from the tone bursts of the cartridge tape. If both numbers agree on the program log, then the correct commercial tape was put on the air as called for by its respective data card.

Make-up and Handling of Music Tapes

The making up of music tapes varies in complexity depending on the type of musical format used. Generally speaking, the "good music"

format is the easiest type with which to deal. The chief reason lies in the fact that the musical selections never get out of date. Once a two-hour tape has been recorded, that tape, if given the proper care, can be used for months or years with little degradation of quality. On the other hand, stations utilizing the "top forty" format will need to re-record their music tapes continually.

Stations using the "good music" format customarily record all musical selections on reel-to-reel machines and at the end of each selection an announcer's voice identifies the selection. After identification, the switching tone is added. This cycle is repeated over and over until the tape is filled. Usually ten-inch tapes are used. On the average, each contains approximately one and one-half hours of music. Each tape has conjugate matching of all musical selections, i.e., all of the same tempo, all which are vocal or all which are instrumental. By loading each of four tape transports with different tempo tapes, the switcher can produce and program the variety which is needed. An example could be one fast tempo instrumental followed by a slow instrumental, then a slow vocal, and so on. The point is that the music director of the station may stack the music cards in the card reader to effect any variety of musical programming which he desires.[57]

The "top forty" type of station seldom uses the reel-to-reel machine for the bulk of its music playback. Instead, each of the "live twenty-five" selections are recorded on cartridges without voice identifications. The announcer makes up a composite reel-to-reel tape of

---

[57]*Planning for Automated Radio Programming*, pp. 21-22.

nothing but comments and record introductions. The switcher cards are stacked in such an order that the announce tape plays first and then the introduced cartridge with the proper musical selection plays. By using this method, a five-hour disc jockey show can be recorded in approximately one and one-half hours, allowing ample time for correction of any mistakes made by the announcer.

In past experience with automated systems it has been discovered that when the expense of time is added to the investment in recorders, reels, tape, and associated equipment, an hour of recorded music costs from three to five times as much as it would if it were programmed live.[58] There are several advantages of automation to be considered, however. By pre-recording, mistakes can be eliminated and complete control over programming is possible. Also, the actual phonograph records are preserved from daily abuse. When all of the advantages of pre-recording are considered, it is apparent that each hour of taped music must be used at least three to five times before its cost can be recouped and any savings effected. This brings on the problem of repetition.

Repetition, if not carefully handled, can mean the demise of any automation system. Listeners soon grow familiar with and eventually tired of the same selection used over and over again. For this reason, no station should take to the air with any less than at least ten days of programming without repetition. The basic tape library for a full-time station should contain about 3,000 selections, and additional music should be added at the rate of 120 to 240 selections per month. This is

---

[58]Coulthurst, *op. cit.*, p. 14.

equivalent to adding approximately four 10-inch reels each month. The entire basic library can be contained on one hundred 10-inch reels, using one mil thickness tape. One mil is a unit of measurement equaling 1/1000 inch. One-half mil tape is too thin for professional machines to handle day after day without damage.[59]

If the musical programming of a station is oriented to currently popular selections and a limited number of musical selections are programmed--such as a "top forty" list--it may be most efficient to reproduce music from tape cartridges, as has been previously suggested. A common pattern of music selection in this type of operation is to play from a library of about 200 selections each week, with a weekly re-recording schedule of about 100 selections. According to one manufacturer, this formula has been effective in many markets where each week about one-half of the music is replaced and the other half, including the current "top forty" list, is retained through its popular life.[60] In this application, each selection is recorded on a separate cartridge for maximum program control and efficient handling.

Radio stations have two alternatives from which to choose in securing their taped music libraries. The first is that of recording from the station's own phonograph records. The second is to subscribe to a syndicated taped music service. Each alternative has its merits and disadvantages. By far the most aggressive and controlled method can be production by the station, provided that the station has an abundance of

---

[59]Planning for Automated Radio Programming, p. 3.

[60]Ibid., p. 6.

personnel and a budget which can afford the expense of both phonograph records and tape. This allows the music to be programmed specifically for the market served and the actual phonograph records can be available for live shows as well.

On the other hand, a new station or a small station with few personnel qualified in production talents may wish to subscribe to the "ready made" music tape services. Most of these services provide the music tapes in two ways. One is the "complete service" in which the music is fully programmed on a single reel of tape and announced by the music tape company announcer. Local station personnel can then concern themselves primarily with the production on non-musical features such as news, commercials, and talk programs. This complete service is available in classical, pop-concert, middle-of-the-road, and country and western categories.[61]

The second type of service is designed for those stations that prefer to use their own local announcers for music introductions. These tapes consist only of music, which must be selected with care in order to provide a true programmed sound.[62] It must be remembered that music may comprise from 60 to 90% of a given radio station's format, and music remains one of radio's chief audience getters. It behooves the wise station management to be thorough in checking the alternatives available, for the music service will be a dominant factor in the total sound of any station.

---

[61]Don W. Clark, Automatic Programming and Logging, A Report to the 1965 NAB Broadcast Engineering Conference, March 21-24, 1965, Washington, D. C., p. 13.

[62]MUSI Catalog (Washington: International Good Music, 1965), p. 2.

CHAPTER IV

TELEVISION PROGRAM AUTOMATION

Basis of Television Program Automation

In categorical terms, the preceding chapter demonstrated radio to be a medium of sound via the microphone. Similarly, television is a medium of vision and sound via the television camera and microphone. It is logical to assume that many of the automation design principles on which radio program automation is predicated could be suitably modified to operate in television applications. This assumption is basically true since the foundation principle underlying all automated programming equipment for television and radio is the function of automatic signal switching.

To better understand how automated programming equipment may be applied to television, it is helpful to review some non-automated techniques of program production.

All techniques of television program production relate to the functioning of the television camera. Creative decisions about the use of the cameras are made by the television director. In live television program production, the usual studio setup puts the director at one end of the studio intercommunications system and the camera crew at the other. The director directs all movements of the camera on the air while at the same time readying other cameras for the next shots. As the program progresses, he directs switching from camera to camera.

The director must constantly strive for an orderly presentation of camera shots. He must present, in logical order, a series of camera shots so arranged as to preserve pictorial continuity. In some circumstances, the method used by the director to move from one shot to another may be as important as the camera shots themselves.

The term "transition" is used to describe the method which the program director utilizes in passing the television program viewer from one picture or series of pictures to the next.

The "switch" or "cut" transition is the simplest of all transitions to perform. It involves abruptly cutting off one picture and switching to the next picture. The switch transition is performed instantaneously.

A second type of transition is the "fade-out" and "fade-in." To accomplish a "fade-out," the program director must manually operate controls which slowly fade the television screen to black. To "fade-in," the director reverses the process, starting with a black screen and slowly fading to the next picture.

The "dissolve" is akin to the fade-out and fade-in techniques. In this method of transition, the first picture becomes steadily weaker while the second becomes stronger on the screen. In reality, this transition is a fade-out simultaneous with a fade-in.

The "wipe" transition occurs when a new picture starts as a small area and grows until it covers the entire screen.

The switch or cut transition is the fastest of all transitions performed by video switching equipment. In modern equipment, the switch occurs during the vertical blanking interval. With high quality

equipment, the switching interval may be as short as a few nanoseconds in length, so short a time as to be considered instantaneous to the human eye. The dissolve, fade-in, and fade-out transitions do not occur instantaneously but have a variable time length. At times the program director may call for a slow fade to black at the end of a commercial or program; at other times he may desire a fast fade to black. Consequently, the time element in a fade, dissolve, and wipe is extremely important from an aesthetic standpoint as well as on a practical basis. This point is substantiated by Bretz:

> . . . the most dangerous aspect of using fade-outs in television is that the length of blank screen between fade-out and fade-in may be too long. Audience interest drops very rapidly when there is nothing on the screen and the fade-in should always be carefully planned and rehearsed.[63]

To the program director and the television audience, each transition has a different aesthetic meaning. For example, a fade to black has a connotation of finality. In contrast, a dissolve retains continuity.

If all television programs were live originations it is doubtful that there would be much opportunity to apply automated program equipment. This is substantiated in the fact that the television program director's job is one which requires an abundance of aesthetic decisions. And, as Stasheff and Bretz emphasize, "automation can never replace art."[64]

In reality, the cost of staging live studio productions and the lack of top talent make extensive live television programming prohibitive

---

[63]Rudy Bretz, Techniques of Television Production (New York: McGraw-Hill Book Company, Inc., 1962), p. 110.

[64]Edward Stasheff and Rudy Bretz, The Television Program (New York: Hill and Wang, 1962), p. 183.

to the majority of television stations. Most stations limit live production work to a few newscasts, commercial announcements, and perhaps one or two variety shows per day. The bulk of material is left to originate from purchased or rented films and pre-recorded video tapes or from one of the major national networks.

Instead of live programming, the local television station's production department, as well as the technical staff, spend most of the broadcast day occupied with switching from network programming to pre-recorded tape commercials and then back to network again. The normal time allotted by a network for breaks for station advertising varies and averages approximately seventy seconds. In an effort to accommodate more local sponsors, the station often subdivides this time interval into smaller intervals.[65] The result has been to place much work and pressure upon station operating personnel. Loading of the projectors and other program sources and then switching rapidly back and forth between the various sources becomes a rigorous and exacting task in the course of an entire broadcast day. In the jargon of broadcasting, this task is often referred to as directing "residue" or switching the "panic period."

Directing "Residue"

Obviously, stopping one playback program source and switching to another does not take much creative ability on the part of the director. However, in respect to "residue" directing, Professors Stasheff and Bretz have the following comment:

---

[65] P. S. Finnegan, "Station-Break Automation for Television," Broadcast Engineering, VIII (February, 1966), 11.

> Although there is nothing creative about directing a series of short spots, especially if they are on film, it is nonetheless a television director's job and calls for the same skill and accuracy that is necessary in directing programs.[66]

Tasks which require little creativity but much precision-timing accuracy are readily adaptable to automated switching equipment. To this end, automated equipment can be utilized to automate a television station's entire residue operation. The director's job, under such circumstances, is to load the proper instructions into a control mechanism instead of calling them from a script at the time of actual broadcast.

The February, 1965, issue of Broadcast Management/Engineering reported on a survey of the broadcast industry concerning application of automated video program systems. The report stated:

> . . . our study indicated that break period [station break] automation is becoming almost commonplace; automatic operation of both video and audio sources, at least during station breaks, is considered essential.[67]

The application of automated equipment can be better understood by analyzing a typical station break. The following sequence could be considered a representative station break:

1. Ending of network program.
2. Two-by-two-inch film slide and audio tape announcement.
3. Motion picture film commercial (25 seconds).
4. Video tape commercial (30 seconds).

---

[66] Stasheff and Bretz, op. cit., p. 177.

[67] "Does TV Automation Pay Off?" Broadcast Management/Engineering, I (February, 1965), 32.

5. Slide for station identification with audio tape or live booth announcement.

6. Returning to network program.

Assuming that the director manually operates the switching equipment during a seventy-second time limit sequence, it is apparent that the director must be rapid and accurate if the execution of such a sequence is to be successfully accomplished.

Hazards are numerous. If the director should start one of the segments a few moments late, the following steps would also start late, thus making it necessary to return to the network program after it has begun. Under the excitement of the break sequence, the operator's fingers may perspire and occasionally slip off the buttons. There is also the likelihood of his inadvertently starting the wrong machine or switching a wrong announcement on the air. All such mistakes are costly to the station, especially during prime revenue producing times. The station's loss of revenue could be quite sizable over a one-year period.

Automating the Break Period

The philosophy of automating this aspect of a television station's operation is based upon relieving the operator (director) of the intensive station-break switching activity. With conventional manual operation, the operator has very little to do for long periods of time between breaks, but is called upon to perform many switching functions rapidly and precisely in a short period. Under the intense strain of such rapid action, mistakes are likely to occur.

The utilization of automatic equipment for program switching spreads out the station break effort over a longer period of time by

allowing the operator to pre-select and double check each switch sequence long before it goes on the air. When the actual station break time arrives, the equipment does the switching automatically.

Automatic Switcher Descriptions

If automatic program switchers for television station use were categorized in the order of capability and technical complexity, the following order would perhaps be typical:

1. Simple preset video switcher.
2. Preset video and audio switcher with lapsed time unit added.
3. Computer-type control with automated video and audio switcher.

Preset Switcher

The preset switcher is a modified form of the conventional manual video switcher. As its name implies, the operator manually pre-selects the program source channels which are to be put on the air before air time arrives. All such selections and adjustments are made at relatively calm times when the operator is able to double check his selections to be certain they are in accord with the break sequence as dictated by the program log.

A hypothetical station break sequence might call for a thirty-second filmed commercial, a five-second station call letter identification on the slide projector, followed by a one-minute commercial from the video tape playback unit. The operator would at his convenience pre-select, i.e., press the individual control panel buttons for each source of video in the order in which each is to occur in the on-air

sequence. Since the hypothetical station break sequence calls first for a thirty-second filmed commercial, the operator would first pre-select the motion picture projector which has the appropriate filmed commercial loaded into it. By pressing the proper control button the projector is placed into "ready" mode. This same procedure would be followed for setting up all remaining on-air playback machinery which is to be used in the sequence. After the control panel has been double checked to be certain that all machines are in the "ready" mode and that the video switcher's pre-select sequence is in accord with the sequence called for by the program log, the operator's involvement is over until air time arrives.

When actual time for the station break arrives, the director or operator pushes a single activator button. This "start" button immediately puts the film projector on the air for its thirty-second filmed announcement. At the conclusion of this announcement, the same start button is once again pressed to start the next video source into action. The most obvious advantage of such a pre-select video switcher lies in the single button for the switching of video signals on the air. This "single button" approach permits the residue directer to keep his eyes on the clock for perfect timing of each event within a break sequence. And with few distractions, he can press a single button to accurately initiate each event.

<u>Lapsed Time Capability</u>

A lapsed time feature for video switchers is the second step toward more complete program automation. By integrating a clock mechanism into video switcher circuitry, the switcher is able to measure the

lapsed time of each program event within a sequence. The lapsed time feature carries the preset switcher one extra step by automatically switching from one video source to another without the director or operator's having to press a start button each time to initiate a new event.

The term "lapsed time counter" implies that the internal clock operates on a pre-instructed time base which has no relation to epochal or standard clock time. This is similar to the clock timer on a kitchen range which counts down time independently of the time of day when the housewife might have set it. For the lapsed time switcher to be effectively utilized, the operator must first pre-select each playback source by pressing the corresponding buttons, as was necessary with the preset video switcher. Secondly, he must be certain that each program segment within the break sequence, whether video tape or film, is carefully timed before air time to be certain that its total length conforms to the time pre-selected on the lapsed time counter.

When air time arrives, the lapsed time video switcher, after being initially triggered at the beginning of the station break period, will automatically continue operating all necessary video for the duration of the break period without intervention by the human operator. Each segment within the break sequence will be switched on and off the air in strict accordance with the pre-instructed time limit as originally loaded into the lapsed time counter by the director or operator.

A problem exists if the operator accidentally misinstructs the lapsed time clock concerning the length of the individual segments. An example of this would be a case where an operator would set up the

switcher for a thirty-second tape commercial and would instruct the timer to this effect but would later accidentally place on the video tape playback machine a one-minute commercial. In such a situation, the lapsed time counter would automatically switch to another source at the end of thirty seconds whether the commercial message were finished or not. Obviously, if the system is to be effectively used it must be double checked to see that no human mistake has been incorporated into the machine's instructions.

In summary, both the pre-select and lapsed time video switchers give the human operator a better chance at quality control of the station break sequence. Switching errors are less likely for two reasons. First, the operator is given ample time to thoroughly analyze, instruct, and double check all on-air and video switching equipment prior to air time. Secondly, when break time arrives, automation does the switching of all video signals on and off the air. Consequently, the operator is relieved of pressured thinking, which is conducive to switching error.

The preset and lapsed time video switchers provide many benefits over conventional manual switchers. The services within an automated program control system are hampered by three major limitations:

1. There is little or no provision for audio signal control.
2. There is limited selection of transitions. Often, a direct switch or "cut" is the only automated transition available.
3. The most confining limitation is that of a limited machine memory. The impact of this limitation necessitates the human operator to reinstruct the automated equipment

frequently, perhaps as often as prior to each break sequence.

To broaden the capabilities of automated television program control equipment, design engineers have turned to developments used in the field of computer technology.

Computer-type Switcher

The American public seems prone to romanticize the role of computers in society. Few modern developments have teased the public's attention more than electronic computers. Sensational press releases mixed with the public's exposure to science fiction have tended to inflate the modern computer image to that of a super-brain with almost omnicient powers. Many people fear such complex machinery and see its emergence as a giant step toward man's subservience to machines.

Electronic computers at their present state of development should not be feared, for computers are tools. No tool can ever be truly effective if it inspires awe in its user instead of trust.

In reality, computers are man's link between the formulation of problems and their eventual solutions. Computers were developed to relieve man of the task of computation. This they have done in terms of advanced speed, accuracy, and versatility. Actually, the term "computer" includes a large gamut of devices from simple office adding machines to complex data analysers capable of solving millions of mathematical computations per minute. The computer operation is predicated on two fundamental characteristics which are generally considered common to every computer:

1. the presence of a memory, and

2. an analytical system for mathematical problem solving.

Computer-type program control equipment is basically an extension of the simple automated systems previously described. Earlier in this chapter, the preset video switcher and lapsed time unit were shown as means by which the airing of television programs could be automated. However, the memory of these devices is limited, and after a small number of switching operations the machine needs reinstruction. Thus, the search for better information storage has led to the application of computer-type memory techniques.

While a computer-type memory is desirable for use in automated television program switching equipment, the computer's quantitative ability in mathematical problem solving finds limited application. Logic circuits are often used in the formation of proper switching paths and as aids in loading the memory section of automatic program control equipment. The real use of a computer's quantitative capability is perhaps better utilized in accounting, billing, and numerical analysis.

Whether such highly refined automated television program control equipment can be referred to as true computers is more a matter of technical interpretation of various electronic circuits and the functions which they perform. The final decision rests with the manufacturer. When the Sarkes Tarzian Company[68] first introduced the APT-1000, it was referred to as computer controlled. Later generations of this same system continue to be listed as computer controlled. Another company,

---

[68] Sarkes Tarzian, Inc., Broadcast Equipment Division, Bloomington, Indiana.

Hancock Telecontrol Corporation,[69] which manufactures a similar machine (UNICON) for automation of television program control, emphatically refuses to refer to its machine as a computer or as computer controlled. Instead, the company prefers to describe the UNICON system as a "special purpose, stored program, digital control programmer with a magnetic core memory," in its equipment brochure.

The term "computer-type" seems to have a better generic connotation than has the word "computer." Therefore, in the interest of accuracy, all advanced television program automation equipment in this section will be referred to as computer-type.

Computer-type automated programming systems are usually composed of three sections:

1. On-air station equipment.
2. Switcher control section.
3. Master programmer section.[70]

On-air Equipment

The on-air section includes all program sources, i.e., program machinery directly involved in playback or origination of the actual video and audio signals of a television program. This category includes video tape recorders and playback units, film projectors, slide projecters, audio recorders, cameras, and other such equipment.

---

[69]Hancock Telecontrol Corporation, 143 Sound Beech Avenue, Old Greenwich, Connecticut.

[70]Finnegan, op. cit., p. 13.

For this equipment to function in an automated system, it must be reliable from a maintenance standpoint and be adaptable to automated switching equipment.[71] These criteria suggest that the equipment be operable by remote control. In order to be capable of remote control operation, on-air equipment should be capable of being started into operation and stopped by sending control pulses to the equipment from a remote location. Some automation systems may require that the on-air equipment be capable of sending back an "end cue" pulse upon completion of each on-air cycle. In reality, virtually all modern professional on-air equipment made for television applications is basically designed around pulse control capabilities.[72] Therefore, many stations converting to a total automated program system will find that much if not all of their existing on-air equipment is easily adaptable to remote control through pulse commands.

Video and Audio Switcher Section

Earlier in this chapter, it was shown that every station, whether automated or not, has some type of video switcher. It is this piece of equipment that the television director manipulates to direct a television program. When operating this switcher manually, he presses the proper control buttons to turn cameras on and off the air, and he may show video tapes or motion picture films at will.

Physically, the video switcher appears as row after row of control buttons. Technically, it is often referred to as a switch matrix. Each individual button in each row of control buttons is capable of

---

[71] *Ibid.*, p. 12. [72] *Ibid.*

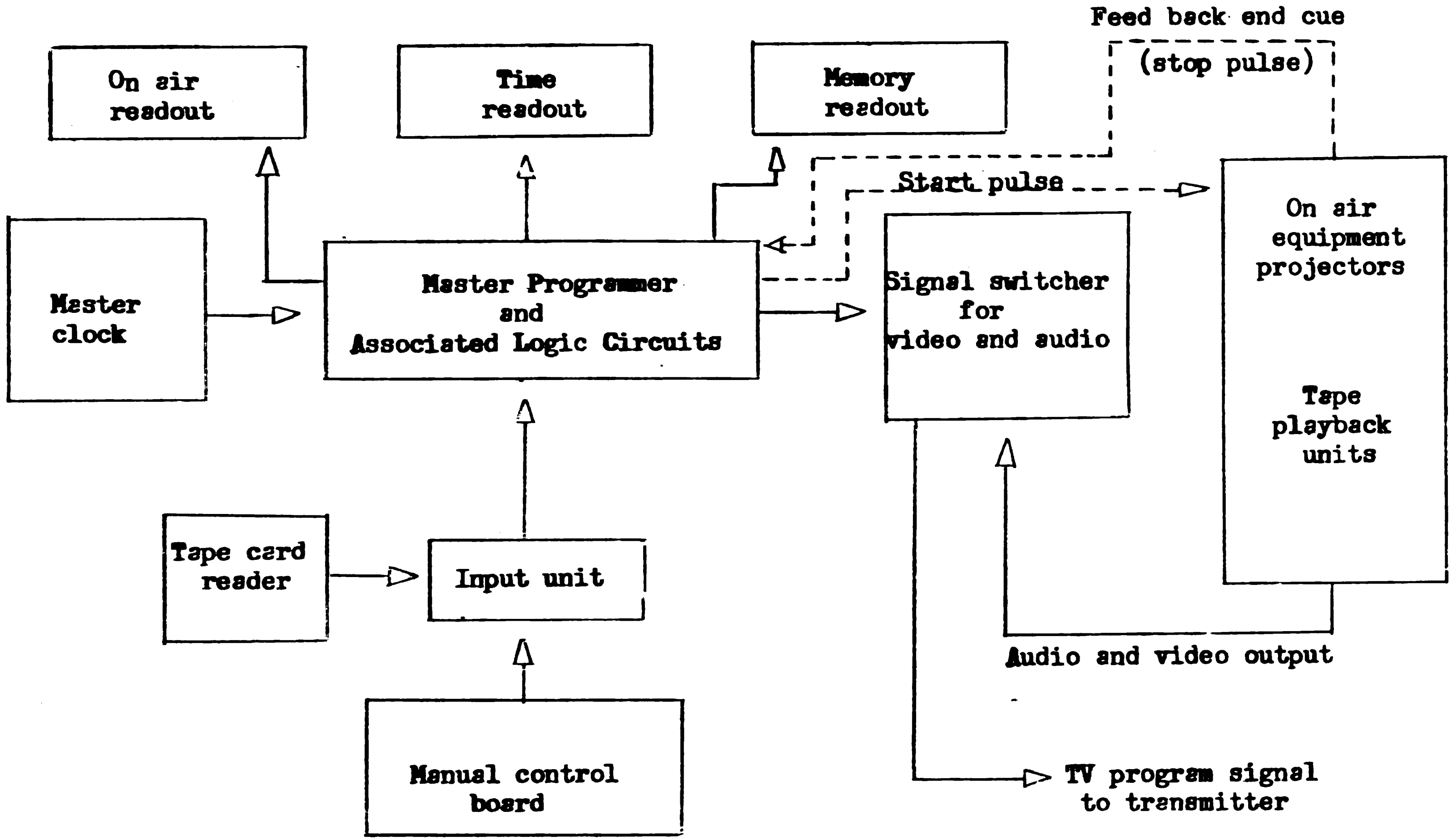


Fig. 2.--Simplified block diagram of a computer-type system arrangement

switching on and off the air a signal from a designated playback unit in the on-air equipment. If there is a large number of on-air equipment sources, then there will be a proportionately large number of control buttons on the face of the video switcher.

Video switcher integration into an automation system demands that the video switcher be capable of remote control operation just as is necessary for the on-air program source equipment. There are two general types of video switchers presently available which meet this requirement. Their technical classifications are: (1) the relay type, and (2) the solid state crossbar type. The solid state, vertical interval type is the more modern of the two.[73]

Equipment manufacturers make a distinction between internal and external video and audio switchers. The internal switcher arrangement contains both the master programmer and audio and video switcher sections as one integral unit. The Sarkes Tarzian APT-1000 and subsequent generations are examples. One authority, Irv Moskowitz of Riker Video Industries, sees the internal switcher arrangement primarily used in large facilities tied to networks for precisely timed cutaways to local stations.[74] The external switcher arrangement indicates that video and audio switching equipment are separate units apart from the master programmer and memory. Stations which already possess modern switching equipment would probably prefer the "external" approach. This entails

---

[73]"Video Switching," Broadcast Management/Engineering, III (December, 1967), 27.

[74]"Automated Video Switching," Broadcast Management/Engineering, III (September, 1967), 40.

purchase of only the computer-type master programmer which would be interfaced or interconnected to their present switchers.

With traditional manual control of television programming, the audio signals are switched on and off the air by an audio operator who sits before an audio switching console and coordinates the sound signal with the picture in accordance with directions from the director of the program. Control of audio signals can be automated by a method similar to that used to automatically switch the video signals. The more complex computer-type systems provide for audio fade-in and fade-out and the mixing of audio signals, as well as direct switching from one on-air program source to another.[75]

In summary, it should be remembered that the video switcher, audio switcher, and all on-air playback equipment are normally under direct push-button control by human operators in a non-automated equipment arrangement. However, if both the switcher and on-air equipment are capable of being operated by electronic pulses from a remote point, then all of the control functions can be relegated to a master programmer.

Master Programmer

The master programmer section bears the same relationship to a complete program automation system as does the brain to the human body. It is the responsibility of this section to command equipment into operation in accordance with the information stored in its memory. A representative list of information needed by such a machine memory includes

---

[75]Brochure of the Hancock Telecontrol Corporation, 143 Sound Beech Avenue, Old Greenwich, Connecticut, p. 10.

length of each spot announcement, video and audio source, type and length of transition between one announcement and the next, and time of day each sequence is to occur. In addition, the master programmer needs to know how each sequence or program segment is to be initiated, whether by a human operator or by a precision master clock within the programmer.[76]

In order for such a master programmer to accomplish its diverse responsibilities it must have a center for (1) memory, (2) command pulse origination, and (3) function display.

Memory systems.—As is the trend in most technological advancement, manufacturers differ in their approach to equipment design. In this respect, manufacturers of television automation equipment are not different. There are three general types of information storage devices which are most commonly used in computer-type automated switching systems. They are: the magnetic core memory; a magnetic drum memory; and punched data cards or punched paper tape, both of which are similar in operation. All three of these methods of memory are common to data storage techniques used in modern computer technology. It would be difficult to assess one approach as better than the others since each memory technique is relative to the application for which it is designed.

The magnetic core memory is composed of thousands of doughnut-shaped pieces of iron, each with approximately a 50 mil-inch outside

---

[76]Brochure of Sarkes Tarzian, Inc., Broadcast Equipment Division, Bloomington, Indiana, p. 4.

diameter.[77] Through the center of these tiny cores run various control wires. When a current is passed through certain of these wires, a magnetic field is built up in individual iron cores. When the current stops in the control wire, the small core retains its magnetic state. This property of the core, to continue in a magnetic state after the current field has been removed, is the property used for strong information in each core. By careful arrangement of the thousands of iron cores along the control wires, meaningful electronic information in the form of a binary mathematical code can be stored and retrieved at will.[78]

The number of magnetic or ferrite cores determines the number of bits of information the memory is capable of storing. Ultimately, the memory's storage capacity is proportional to the amount of program log the memory can memorize and translate into switching action of the on-air equipment.

The magnetic drum memory technique is similar in operation to conventional audio or video magnetic tape recording machines. The recording medium is a moving oxide surface scanned by a recording head. After information has been recorded, it may be retrieved at a rapid pace through a magnetic playback head.

Whereas the magnetic core memory is an all electronic system for data storage, the magnetic drum memory is classified as an electromechanical device since mechanical force must be applied to move the

---

[77]Brochure of the Hancock Telecontrol Corporation, 143 Sound Beech Avenue, Old Greenwich, Connecticut, p. 4.

[78]*Loc. cit.*

recording medium, in this case the oxide-covered drum assembly.[79] This is potentially a significant design factor in as much as electro-mechanical devices are slower in their operation speeds than are exclusively electronic devices.

Chapter III showed how data cards could be used as a memory device for control of radio program equipment. Essentially, such devices work on the principle of punched holes in a card or paper tape, with each hole placed in a format fashion. The format arrangement is made relative to an arbitrary mathematical standard which allows a computer or other sensing machinery to read the card and translate this stored information into significant action.

The idea of using punched paper tape or data cards for a storage medium is not a new one. Many of the present ideas about punched card processing came from the work of Dr. Herman Hollerith, whose tabulating machine was used to record the 1890 United States census by the use of tape. Dr. Hollerith later founded the forerunner of the International Business Machines Corporation.[80]

Generally, the field of computer technology assigns data cards and card reading equipment to a group of devices called input/output equipment. This implies that data cards are most useful in loading or unloading stored information into or out of a computer's magnetic memory.[81]

---

[79]Automatic Program Control System, APC-101, brochure of Central Dynamics, Ltd., 147 Hymus Boulevard, Pointe Claire, Quebec, 1965, p. 4.

[80]William Barden, "High-Speed Punched-Card Readers," Electronics World (January, 1967), 43.

[81]Ibid., p. 42.

Data card and punched tape handling equipment is inherently mechanical in nature. Therefore, it is no match in speed as compared to magnetic memory equipment. The maxim "time is money" is extremely pertinent to computer technology. Speed is most important to corporations or government agencies which have great quantities of data to be processed, such as utility bills, bank statements, sales slips, or income tax returns. Many large computer complexes use magnetic memory equipment because of its high operational speed, while the punched data cards are retained to feed information into and out of the computer after data have undergone the desired mathematical analysis. Thus the name input/output equipment has been given to data card machinery.

The operational speed of computer-type automation equipment for television program control is not so vitally important, since the number and speed of switching functions which must be performed are relatively few and slow by machine standards. Therefore, data card memory equipment which is considered too slow and cumbersome to be used in some computer applications may find effective use as the main data storage system in some television and radio switching equipment. Several advantages can be cited for data card memory equipment. Unit cost of the individual card is low. Cards can be readily replaced if damaged or easily modified if the data change. Each card usually constitutes a unit record, or complete information on one subject. This means that groups or files of cards about one particular set of subjects are easily expanded or modified by simply removing them or adding individual cards into the stack. Finally, one cannot look at a magnetic tape or magnetic

core memory and expect to see the data stored there as is possible with data cards.

In summation, broadcast equipment manufacturers differ in their designs of automated computer-type switching equipment. All are attempting to employ the latest developments available to them from the field of computer technology. To this end, the magnetic core, data card, magnetic drum, and tape have emerged as the more advanced methods used for machine information storage. Some manufacturers have chosen to use a combination of both magnetic and data card data storage in order to derive the advantages of both memory techniques.[82]

The more important criteria in selecting and designing memory systems for computer-type television program control include: (1) simplicity of operation in entering data and extracting data from a memory unit, (2) size of storage capacity and flexibility, and (3) retrieval accuracy. A fourth consideration, that of ultra-fast memory operational speed, does not seem to be of primary concern in television and radio program switching systems.

Pulse origination.--As discussed earlier, the master programmer is the control point from which all system commands radiate. Subservient equipment includes the video and audio switchers and associated program playback equipment. In addition to being the center for system memory, the master programmer must possess special circuitry to communicate with and exercise control over the sub-equipment under its command. This is accomplished through pulse origination and reception similar to

---

[82] Ibid., p. 4.

the way a human brain routes motor nerve pulses to actuate coordinated muscle movement in various body parts.

Three general classes of pulses are generated by the programmer subsequent to the stimulation of its memory. They are: function control, signal switching, and visual display pulses.[83]

In general, function control pulses are routed from the master programmer to the on-air equipment. The master programmer utilizes these pulses to put on-air equipment into stand-by or ready condition, or it might be used to physically start the motors of individual units of playback equipment.

Whereas the function control pulses are directed from the master programmer to the on-air equipment, signal switching pulses travel from the programmer to the video and audio switchers. These pulses instruct the video and audio switchers as to the correct playback unit so that the proper sound and picture may be coordinated with the desired transition between program segments.

The third type of pulse, visual display, serves still another specialized function which is not directly involved in controlling the on-air program signals. It is used to activate special read-out devices in the function display section. This application contrasts to function control and signal switching pulses which are directly involved in putting sound and picture on the air.

Visual display.—Essentially, this section exists to inform the human operator of the step-by-step functioning of the master programmer.

---

[83] Brochure of Hancock Telecontrol Corporation, 143 Sound Beach Avenue, Old Greenwich, Connecticut, p. 10.

Even without the monitoring feature that the readout section provides, the master programmer probably could handle its prime chore of getting television program segments on and off the air. Yet the function display section is considered highly essential for the most effective operation and versatility of computer-type automated program control machinery.[84]

Function display is facilitated through the use of electrical or a combination of electrical and mechanical readout devices. One such readout device under the trade name "Nixie tube," consists of a glass container, inside of which are placed several specially shaped wires technically referred to as control cathodes. The glass container is pressurized with neon or a similar type of gas. When an electrical charge is applied to the internal wire within the glass container, the neon gas will ionize and give off a soft red or orange glow which is plainly visible around the outer edge of the control wire. If the control wire is arranged, for example, in the shape of the numeral "9", when electricity is applied to the wire the gas will ionize and the numeral "9" will be visible as a soft glow. One such container can be manufactured to accommodate many control cathodes, thereby enabling each glass container to have the capability of displaying any numeral between 0 and 9 on command. Six units, such as might be connected to a digital clock, could continually display the countdown of the time of day in hours, minutes, and seconds.

---

[84]P. S. Finnegan, "Station-Break Automation for Television," Broadcast Engineering, VIII (February, 1966), 12.

Other display devices may use a principle similar to a tiny slide projector.[85] There may be several translucent slides on which are written different numbers or letters of the alphabet. Behind the individual slides is an arrangement of tiny light bulbs. The light from a single bulb shines through its respective slide and projects the slide content on a small glass screen. By turning on different light bulbs behind the various slides, a variety of information can be displayed on one tiny screen.

Visual display pulses from the master programmer control all read-out devices, thereby enabling the human operator to see every action of the master programmer both before and as it occurs. In order to meet its visual display objective, the computer-type master programmer usually will provide at least four individual groups of display devices.[86] One display group counts down time in hours, minutes, and seconds in accordance with a highly accurate digital clock which serves as the time reference source to the master programmer's memory section. Another portion of a display group informs the operator which unit of playback program equipment is actually on the air. In addition, the display group counts down the number of seconds that remain before the program source is to be switched off the air, and it provides an indication as to what type of transition will be used in bringing the next program event to the air. Still another visual display group is

---

[85]Brochure of Hancock Telecontrol Corporation, 143 Sound Beech Avenue, Old Greenwich, Connecticut, p. 12.

[86]Brochure of Sarkes Tarzian, Inc., Broadcast Equipment Division, Bloomington, Indiana, p. 3.

connected to circuitry which scans the programmer memory and indicates to the second what time the next program event is to occur and from which program source it is to originate. Optional displays can be arranged to provide information about the next event stored within the programmer memory, or can be used alternatively to random search through the master programmer memory for specific data. This capability is helpful for memory verification or is useful in reloading up-dated information into the programmer memory to match changes in the daily station program log.

Operation Analysis

Computer-type program control equipment demonstrates its greatest potential when operated in an automatic mode. In the automatic mode, it is possible to enter into the master programmer section the desired switching events sequence, together with the duration time or real time of each program event. As was shown earlier in the section on machine memory, the basic storage capacity of the master programmer governs the number of program switching events that can occur automatically before it is necessary for the human operator to intervene and reload the memory with new information.

Usually, data for the master programmer memory section is entered into that section by means of a set of push buttons on a control panel; or in the case of data card use the information would be prior punched into data cards, perhaps by another department of the station, and an automatic card reader would transfer the card data directly into the programmer memory.

Typical of the basic information contained in each program event address and which is needed by the memory section in order to switch a single program event are:

1. selection of the video and audio signal source,
2. whether the video signal is black-and-white or color,
3. the type of transition desired to put an event on-air,
4. the actual clock time that on-air switching is to occur or the duration of on-air time remaining before an event is to be switched off, and
5. the method of initiation to be used in switching an event on-air.

The master programmer memory accepts such instruction, called "words" in the semantics of the computer. All the combined data about one program event comprise one "word." Each word is then assigned a number, often referred to as an "address."[87] The programmer is to quickly locate and execute data contained in each word. Equipment manufacturers spare no effort in making the loading of information into the master programmer section as easy an operation as possible. This is another crucial area where man and machine must communicate. In order to do so effectively, a clear and well defined procedure must be established.

Some equipment is designed with apparatus to aid the human operator in finding his own mistakes. Should the memory be loaded with inadequate data, a light, often referred to as a "parity" light, flashes

---

[87] Ibid., p. 2.

to warn the operator of an information loading error. Also helpful in this respect are the visual display panels which automatically read-out, in one of the visual display panels, information as it is fed to the memory section. This serves to verify to the operator that instructions are correct and are indeed memorized by the memory section. In the event that information errors are discovered, designers are careful to provide ways in which corrections may be inserted without disturbing the remaining part of the stored information. Obviously, an extension of this same feature allows updated information or scheduling changes to be entered into the computer-type memory section anytime up until moments before air time.

Advanced arrangement of circuitry within the master programmer allows the omission of certain repetitive operating instructions which might be necessary for less complex program control systems. Exemplary of this feature is the programmer's automatic handling of on-air equipment pre-roll cues. Pre-roll pertains to the time length needed by a given program source to maintain operational speed prior to being switched on the air. Video tape playback units may require ten-seconds roll time before sound and picture are stabilized sufficiently to be switched on the air. Film projectors may require only five seconds. Since playback units are a permanent part of the complete program automation system, the roll time of each of the various machines can be permanently memorized by the master programmer, thereby eliminating these data as part of the routine machine operating instructions. Regardless of which playback unit is selected for on-air duty, the

master programmer will automatically provide the correct amount of preroll needed prior to switching that unit on the air.

When the operator has entered all of the necessary data into the memory section of the master programmer, the system is ready for automatic control over all of the station's on-air audio and video. When the system is operating in an automatic mode, the master programmer memory section is influenced by a highly accurate master clock, which issues pulses second-by-second to the programmer section. Switching actions are initiated by comparing the read time of this clock to the memorized time previously stored within the programmer memory section by the human operator. When the real clock time corresponds to the memorized time, the master programmer switches the event on the air.

A need for versatility often dictates that the master programmer section use other methods or a combination of other methods for switching from event to event. One alternative is counting down the duration time of the program event on the air. This method of operation requires that the memory section be prior instructed of the actual length of each on-air program event. When the allotted time or on-air duration time is expired in accord with earlier memorized time, the event is switched off and the next event in sequence is switched on the air.

A third method of initiating switching from event to event is the cue system. This technique entails the sending of an end cue pulse back from the on-air playback machines to the master programmer. End-cue pulses are easily generated by on-air playback equipment. This is accomplished in a manner similar to that which is used by radio program automation equipment as described in Chapter III. Subsonic cue tones, or a tiny strip of tin-foil spliced into the end leader of a film, or video tape may be used. The tone, or metal strip, is sensed and causes a pulse to be directed back to the master programmer. This in turn stimulates a switch through the proper transition to the next event.

In summary, perhaps it is significant to again emphasize that automated program control machinery, regardless of its level of advancement, is never complete without an overseeing human attendant. Nevertheless, system effectiveness demands that computer-type program control systems be designed to minimize the operator's involvement with actual on-air button pushing. To this end, the human operator's primary concern is relegated to two principal areas. The first consists of correctly loading the master programmer memory section with all of the pertinent data needed by the machine system in order to carry out its switching procedure. The second consists of monitoring the system's overall performance through the many visual displays.

If and when contingencies arise, a single over-ride control button may be pressed which instantly disengages the computer-type master programmer from all station equipment, thereby allowing program signals to be switched manually as in a conventional non-automated television station.

Published reports from broadcast stations which are using advanced automated program control equipment indicate general success and satisfaction.[88] Amid reports of success, however, there is some

---

[88]"Automated Video Switching," Broadcast Management/Engineering III (September, 1967), 33.

criticism. Some stations are concerned with inaccurate timing on the part of the major national networks. This makes it difficult to air station-break sequences on a real time basis, thus crippling one operational mode of computer-type systems. One broadcaster has stated, "Since network timings are not dependable, the manual take-over mode is used quite extensively. . . ."[89] Others suggest that the solution to this problem might be the origination of standardized cue pulses from the network which would automatically trigger program control systems at the various affiliated stations.[90]

A second area of desired improvement is the visual read-out section. Some operators of advanced computer-type sustems insist on an expansion of read-out capability, particularly for up-coming events. Central Dynamics, Limited, has appreached this problem with a cathode ray tube type of display on which all events in the magnetic memory are displayed alpha-numerically and move up the tube as the sequence progresses. The cathode ray tube used is similar to the ordinary picture tube used in most television receivers.[91] This approach means that the operators may view the entire switching sequence long before it goes on the air. As the sequence progresses step by step, the displayed data slowly move up the face of the display tube in order to facilitate easy reading by the operator.

The material contained in this chapter is evidence that technological advancement is adequant to surmount the majority of problems

---

[89]*Ibid.*, p. 39. [90]*Ibid.*, p. 33.

[91]"Automated Video Switching," *op. cit.*, p. 40.

associated with television program control. Automated program control constitutes but one phase of station operation. Therefore, it is logical to assume that the broadcast industry, along with other industries, will extend automated techniques into all areas of their businesses as rapidly as benefits can be realized.

CHAPTER V

AUTOMATED DATA PROCESSING

Fundamental Office Routine

Ostensibly, of course, the broadcast industry is primarily concerned with broadcasting programs and announcements. For that reason, preceding chapters have described the capabilities of automation in the production of program materials for broadcasting. Equal in importance to program production is the necessary accounting and scheduling functions which are delegated to what is referred to in most stations as the traffic and accounting departments. To understand how automation is applicable in this field of broadcast operation, a basic knowledge is needed of departmental functions and the resultant communication between them.

Hypothetically, each commercial radio or television program or commercial advertisement begins with a client's purchasing a quantity of air time from a member of the station's sales force. Upon completion of the sale, the salesman fills out a form known as a time order. The time order is submitted to the traffic department. The time order alerts the traffic department to what kind of program or announcement has been sold, to whom, the length of time needed for broadcast, the number of broadcasts sold, and the tentative dates for these broadcasts. From these data, the traffic department proceeds to schedule these broadcast times, as ordered, on the daily program log. When the daily program log is

completed, it is passed to the program department whose duty it is to transform the program log's schedule into picture and sound for the audience. When the program department confirms that the client's broadcast time has indeed been put on the air, it is the accounting department's function to compute the total charge for the service and bill the client at the month's end. Although this is a highly simplified explanation of a departmental function, it is obvious that both scheduling and accounting functions are office tasks. See Figure 3.

In the introduction of automation to office methods, it is first necessary to determine which phases of the office activities can be performed by machines and which phases need human interpretation and handling. See Table III.

A previous study reveals that in every mechanized office routine the work functions fall into seven basic categories:

1. preparing sources of original documents;
2. introducing or putting data from these documents into record-keeping systems;
3. manipulating, or working, with the data such as assembly sorting and classification of data, reference to and extraction of related data previously stored, and computation;
4. storing data, including temporary filing of intermediate results and other data in process and the maintenance of files of carry-forward data;
5. withdrawing or taking out results from processing;

Fig. 3.--Channels of interdepartmental communication

*Dotted lines represent possible machine-processed data.

1. Channel one represents the original contact between client and salesman and the resultant time order.

2. Arrow number two shows the salesman's time order being transmitted to the traffic department for scheduling on the program log. The time order informs the traffic department as to what kind of program has been sold, to whom, the length of time needed for broadcast, number of broadcasts sold, and dates for these broadcasts. Such basic information is necessary for scheduling.

3. The scheduling process culminates in the daily program log. This log contains all data needed by the program department to implement the actual broadcast. If automated equipment is employed, the program log is typed or printed automatically, and automatic program producing equipment in the program department may be directly instructed by the scheduling computer in the traffic department. With automation, data in channel three are machine processed.

4. Before the sales staff can make a time sale it is necessary to know whether the time spot is vacant. The traffic department must constantly inform salesmen as to which air time is available. If automation is used in this area, time availabilities can be known at any given time. Channel four can therefore be considered to be electronic data processed.

5, 6, 7. These arrows represent normal interoffice memoranda which management may find necessary in supervision of the station's daily operation. Administration duties or supervisory control fall into operations that cannot be mechanized; consequently, there are no provisions for electronic data processing in these channels.

8. The accounting department is responsible for the tabulating and mailing of monthly statements to the various clients. Since this is a computing function, it is easily automated. The TRAFFACCOUNTING system, for instance, could automatically print all statements, thereby making this channel machine processed.

9. Arrow nine shows data being fed back to management for evaluation. The data fed back to management can be of a number of different types. Included are listings of accounts receivable, accounts payable, sales projections, product analysis, or any listings of the station's financial status. All of these functions are applicable to data processors.

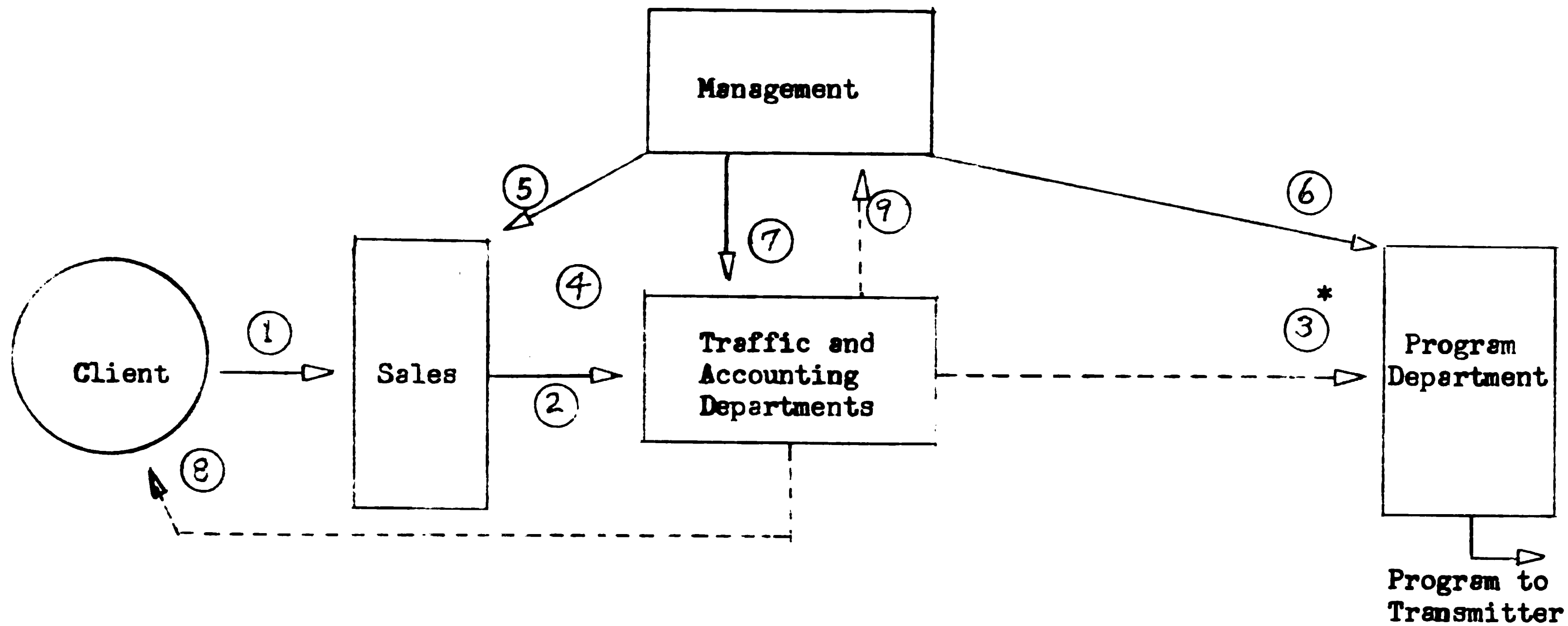


Fig. 3.--Channels of interdepartmental communication

TABLE III

A COMPARISON OF DEPARTMENTAL FUNCTION ACCORDING TO THE TYPE OF OFFICE ROUTINE UTILIZED

Departmental Duties	Type of Office Routine
Scheduling (traffic department) Availabilities Production of daily program log Commercial announcement rotation and film rotation	Sorting, classification
Writing of commercial announcements (traffic department)	Not applicable to machine processing, original document preparation
Accounting (accounting department) Tabulation of accounts receivable Payroll Accounts payable, operating costs Other cost accounting as might be necessary for operation of the station	Computation
Billing (accounting department) Preparation of clients' statements Preparation of affidavits of performance	Sorting, classification, computation
Research (perhaps the accounting department) Sales projection Product analysis Audience analysis (demographic data)	Sorting, classification, computation

6. summarizing results; and

7. supervising.[92]

This same study suggests that sorting, classification, and computation functions normally can be mechanized. However, the preparation of original documents, input operations, and supervisory control usually cannot be mechanized with any degree of profitability.[93]

If the functions of the traffic department and accounting department are analyzed, it is apparent that the majority of their duties fall into the sorting classification, and computation functions, all of which lend themselves to mechanization.

Departmental organization varies from station to station. Some stations, for instance, might separate the traffic department from the accounting department. A large station, with more operating capital, might be more likely to have separate research facilities. The important point to be realized is that where there are similar office routines there is the possibility that more than one department may be able to utilize the same basic type of automated equipment.

Electronic Data Processing

The technology of office automation is known as electronic data processing, often abbreviated as EDP. According to an article by Ross Lovell of the College of Business Administration of the University of Houston, electronic data processing can be broadly defined as the use

---

[92] Ralph Griese, "An Approach to the Human Problem in Systems Mechanizations" (unpublished Master's thesis, Engineering School, Michigan State University, 1959), p. 11.

[93] Ibid.

of electronic computers and data processing machines to aid in the following operations:

1. collection and processing data needed by management to make decisions,
2. lower-level management decision-making operations,
3. issuance of the necessary paper work to instruct the organization in accordance with those decisions, and
4. measurement of actual progress and feedback for management control.[94]

Operating well within this broad definition of EDP, there are systems available to accomplish the office functions of broadcasting stations. The TRAFFACCOUNTING system, developed by a company in Denver, Colorado, is one such system, and TASCOM by Sarkes Tarzian, Inc., is another. These systems are not identical in function, as will be explained.

Application of Electronic Data Processing

The TRAFFACCOUNTING EDP system is applicable in both the traffic and accounting departments.[95] This system combines an IBM card sorter, card punch, and card-reading machine with a tabulator. This unit of machines is capable of tending to all scheduling, accounting, billing, and, to some degree, market research as needed by the modern broadcaster. In understanding the application of these EDP systems, occasional reference to Figure 3, page 86, will prove helpful.

In the area of scheduling, the TRAFFACCOUNTING system automatically keeps constant check on the number of time availabilities open

---

[94]Ross W. Lovell, "The Nature of EDP," University of Houston Business Review (1964), 4-5.

[95]TRAFFACCOUNTING for Broadcasters (Denver, Colorado: TRAFFACCOUNTING Accounting and Data Processing Company, 1965), pp. 1-3.

at any given time on the program log. This information is constantly fed back to the salesmen in the form of automatically typed lists. New time orders are automatically inserted on the daily program log and are projected to those tentative logs to be made at a later date. Expired orders are automatically removed after the date of last broadcast, and orders are automatically deleted on the proper days. In the event that a salesman should sell a time order a very short time before it is to go on the air, blank spaces are left on the log to meet such tight deadlines. The IBM tabulator machine automatically prints a final copy of the completed program log. Printing time could be expected to vary between 15 and 25 minutes daily, depending on the length of broadcast day and the commercial load. At the completion of this automatic typing of the program log, the log is ready to be submitted to the program production department in order that preparation may be made for the next day's broadcasting.

In the area of accounting, the same equipment used for scheduling and making the program log can produce reports on accounts receivable, when due, and which salesman sold each account. The equipment can be expanded with a check printer to handle payroll or it can even handle all accounting chores such as profit and loss, accounts payable, and cash receipts, all of which can be totaled daily.

Some stations send affidavits in addition to statements to their clients showing the time and date of broadcast of all accounts. The TRAFFACCOUNTING system will handle account affidavits along with the automatic printing of the monthly statements. Included will be the subtracted credits for payments received during the previous month and the

current month's balance. The statements are ready for immediate mailing following the automatic printing.

A limited amount of research is available to management in the form of daily sales projections. Each day, management knows how many dollars are on the books for the present month and for future months. Projections are available for individual salesmen at all times. Sales product analysis is also a possibility with this type of operation. The weaknesses or potential dangers in billing can be spotted by showing which product categories are strong and which are weak. Each month, management can receive an analysis showing the total number of announcements and the total number of dollars received from each of the different product categories. The sales product analysis may be further broken down by the salesmen to show national vs. local accounts or direct contact sales vs. advertising agency sales.

The TRAFFACCOUNTING system is suited for needs of modern radio stations and it is also capable of being used by the television broadcaster in the areas of accounting and billing.

A long-time leader in the electronic data processing field, the IBM Company, also promotes much of its standard equipment lines for radio and television usage. IBM equipment can be arranged for automated program logging and accounting operations. One typical IBM arrangement is used by the Columbus (Georgia) Broadcasting Company, Inc.[96] In this organization, daily program logs begin with an IBM 029 card punch machine. Time orders, change orders, program changes, and promotional

---

[96]"Data Processing," Broadcast Management/Engineering, III (September, 1967), 43.

and public service announcements are all punched into individual data cards. For each account, a color-coded master card is key-punched with account name and category number, salesman's identification, audio and video source, day of week, time and production cost, and contract starting and ending dates.

These master cards are returned to the traffic department and placed in a visible line display according to the sequence they are called for in the daily program log.

After the card sequence has been checked by the traffic department, the cards are given to the data processing department, where a 514 duplicate machine punches duplicate cards which are machine read, resulting in an automatically produced day's program log. The log itself is printed on a 402 accounting machine. After sorting on an 082 sorter, either alphabetically or numerically, the cards can be fed into the accounting machine to print such reports as revenue distribution, sales commissions, and similar data. It is important to note again that if a station possesses automated program switching equipment, the card stack could also be passed along to the production department and fed into an automated computer-type program switching device, as described in the preceding chapter, thereby completing a total system from time order to actual on-air switching of the television program signal.

The TASCOM system developed by Sarkes Tarzian, Inc., is representative of equipment designed primarily for television traffic department usage.[97] TASCOM is not a combination traffic and accounting

---

[97]TASCOM Traffic Availabilities Scheduling Computer (Bloomington, Indiana: Sarkes Tarzian, Inc., 1965), pp. 1-5.

department instrument; it is capable of handling traffic time availabilities and scheduling duties only.

Problems encountered by the scheduling department may include some of the following:

1. Films are not always of the same length from week to week. The extra time must be filled.
2. Sometimes a station's commercial time is not sold as of a few days prior to the on-air time. The department must be flexible to deadlines.
3. Unsold time must be determined in sufficient time to alert the sales department and salesmen and keep them informed until almost the last moment before the commercial time goes on the air or before the final program log is written.
4. Some sponsors have a variety of product types that are covered under one sales contract and their on-air commercials must be rotated to give proper coverage to all products.
5. Conflicting commercials must not be adjacent to each other on the program log. Conflicting commercials are those which advertise the same type of product.
6. Last moment changes must be included in the log without causing conflicts or timing errors.

The above is not a complete list but it is representative of the problems faced by the traffic department daily.

The TASCOM system can handle all of these problems on an automatic basis.[98] The key to the technique of this high-speed data processor lies in its memory system, composed of the tape cartridges which are capable of storing the necessary data used in computing the time limits and schedules for each day's program log. Each tape cartridge used by the machine holds an amount of data equivalent to 5,000 punched cards. The system uses an automatic typewriter for both the receiving and the transmitting of back data. Some of the instructions needed for production of the completed program log include:

1. Day of the week. In some cases stations might wish to store information for as long as six months in the computer. Thus, data for each day of the week would be stored on a single tape cartridge.
2. Time slot. This would be the actual time the broadcast is to go on the air.
3. Title. The name of the show or the name of a sponsor of a commercial.
4. Duration time. This is the actual time on the air when the particular material is to be broadcast.
5. Other information which might be required in scheduling the broadcast. For example, a code number may be desired for commercials of certain types in order that the automatic equipment would not schedule conflicting commercials adjacent to each other.

---

[98] Ibid., p. 3.

The Cox Broadcasting Corporation, an Atlanta (Georgia) based station chain, makes maximum use of automated data-processing equipment.[99] The nucleus of this company's electronic data-processing machinery is a Honeywell 200 computer. Cox reportedly views the use of this computer for sales, research, and traffic operations as more valuable than for billing and accounting purposes, although billing and accounting can be accomplished with ease on such advanced equipment. Some of the applications to which this company puts its computer include: (1) log preparation, (2) sales availability, (3) weekly sales projection, (4) billing, (5) personnel reports, and (6) film inventory. In addition, analyses for Federal Communications Commission reports are possible by accumulating information contained on the daily program logs. Each month, this information is summarized showing the amount of time actually broadcast for each FCC program type and source. In the area of research, any Cox station can take a public opinion poll on any subject and have the results cross-tabulated by the computer in relation to demographic breakdowns.

Station market data received from the American Research Bureau or the A. C. Nielsen Company can be further computer-processed to provide a complete local breakdown of station strengths and weaknesses as well as those of the competitors. Such analyses are extremely helpful to existing and prospective advertisers in deciding logical air time buys. The presence of this capability, obviously, is a powerful sales tool for both local and national sales.

---

[99]"Data Processing," op. cit., pp. 44-45.

In summation, the field of electronic data processing is not a new one. Many industries have reaped its benefits for a number of years. However, the application of automated data techniques in the broadcasting industry is comparatively new. Some large market stations are already successfully utilizing electronic data processing. Others, perhaps, plan to follow that route soon. Stations whose future plans do include the use of automated data processing equipment and who have begun feasibility studies should consider the benefits of a total system. This means, of course, communication between the automatic machinery within the system. Output data from one process such as the traffic department's program log in the form of card stacks must be compatible with the data input to the automatic equipment in the program production department. Even if capital equipment must be acquired separately and over a period of time, it appears that through long-range planning and judicious equipment selection a station could set its own pace in moving toward a complete system, with the assurance that the various automatic devices will perform satisfactorily both now and later within an automated system.

CHAPTER VI

AUTOMATION'S FUTURE IN RADIO AND TELEVISION

This study has concentrated on automation as a continuous process using separate automatic machines connected in series. This concept involves the handling of production from one operation to another by mechanical means, with little need for human assistance. Emphasis is placed on the relationship of one machine to others, all working together to produce the final product, in this case a radio or a television program or a traffic or billing process. In assessing this concept as it relates to the broadcasting industry, it appears unwise to suggest that every television or radio station could receive immediate benefits from a totally automated system, for automation can be applied only as rapidly as stations are able to comprehend the need and absorb the range of benefits available to them. Obviously, stations are not able to do this on an equal basis. However, if many in the industry continue to find success in the simpler forms of automation equipment, a trend could evolve toward the total systems approach. This trend is predicated in large part on two important considerations:

1. the amount of capital which can be budgeted with an expectation of recovery in a given length of time, and
2. how rapidly automatic devices can be developed and approved to effectively supplement the total systems approach.

The first consideration is difficult to analyze because the amount of capital which is available to a given station depends on the individual station's financial stability. There is a wide degree of variation in finances from station to station, and this information is not usually available for research. However, up to this point, equipment manufacturers continue to present encouraging payout periods on their automated equipment lines. Their data are usually extrapolated from experience derived from an ever broadening cross-section of previous buyers in many and varied markets both in and out of the United States.

The second consideration, new equipment development, is very much alive with activity. Even a cursory examination of trade journals and equipment brochures will attest to the immense effort at development and application of new and more efficient means of automation for the broadcasting industry. J. L. Smith, manager of Broadcast Systems Engineering, Collins Radio Company, believes that

> the capability for automation in the broadcast industry now exists to a degree far in excess of its present use. It is only necessary to put to work the capabilities we now have. . . .[100]

To this end, the National Association of Broadcasters continues to wage a continuous effort to insure that the industry has opportunity to take advantage of the many capabilities now at hand.

---

[100] J. L. Smith, "What the Experts Predict--Man and Machine," Broadcast Management/Engineering, III (September, 1967), 28.

Remote Control of Television Transmitters

Chapter II of this study demonstrated the profitability of remote control of radio broadcast transmitters. Ultra high frequency television stations (UHF, channels 14 through 83) were granted permission by the Federal Communications Commission (FCC) on May 6, 1963, to operate by remote control. At the end of 1963, very high frequency television stations (VHF, channels 2 through 13) were the only broadcasting facilities not allowed to use this capability. On February 24, 1965, the National Association of Broadcasters (NAB) petitioned the FCC to extend to those very high frequency stations the privilege of operating television transmitters by remote control.[101] This formal NAB petition, commenting on Rulemaking Notice Number 735, was filed with the FCC after what was thought to be an adequate period of experimentation. The main issue was whether such remote control permission would in any way result in a degradation of the Commission's standards of good engineering practices. The NAB petition was based on successful tests which had been conducted at four television stations. The four stations reported a combined total of 12,000 operational hours without a single malfunction.[102] In spite of these seemingly significant results, the FCC decided against allowing remote operation of VHF television transmitters.

The denial of the NAB petition was discussed during the Twenty-first Annual Engineering Conference held in conjunction with the 1967

---

[101] "Remote Control of TV Transmitters," Broadcast Management/ Engineering, I (July, 1965), 41.

[102] Ibid.

NAB Convention, April 3-5. During one session, FCC engineers made clear that there should be another petition filed later by the NAB. Wallace E. Johnson, FCC Broadcast Bureau, Washington, stated that "the wording of the denial suggests the approach to be followed in any forthcoming petition to the FCC to assure adequate maintenance of remotely situated transmitters."[103] Presumably, this clarification of the FCC position regarding adequate maintenance of remote controlled transmitters will result in continued NAB petitioning until a favorable ruling is achieved.

Automatic FM Transmitter

At the present, an automatic FM broadcast transmitter is entirely feasible. The FCC has been petitioned to change the rules in order to permit its operation.[104] The Collins Radio Company is also seeking FCC approval for associated automatic monitoring equipment. As envisioned, at the beginning of each broadcast day the transmitter would be turned on automatically by a time clock or other automatic mechanism. From that point to sign-off, no further attention to the transmitter would be required unless a fault should develop or it would be desirable to switch from monaural to stereophonic sound. At the end of the broadcast day, the transmitter could be turned off, either manually, by remote control, or automatically.[105]

---

[103] "NAB Report," Broadcast Engineering (May, 1967), 57.

[104] "Self Monitoring of Automatic FM Transmitters," Broadcast Engineering (September, 1967), 42.

[105] Ibid.

Automated monitoring facilities act as sentinels to guard against erratic transmitter operation. If any of the transmitter's parameters such as voltages, broadcast frequency deviations, or other metered points begin to vary toward a tolerance limit, an alarm is sounded. This alarm may be transmitted to any location such as the maintenance engineer's home or the studio. Should the monitoring equipment detect a totally out-of-tolerance condition on certain critical parameters, indicating unlawful operation, the transmitter would be removed from the air automatically and immediately. In the event that the out-of-tolerance condition is only temporary, the transmitter attempts to recycle itself "on" again for a total of three times. After the third attempt, the transmitter indicates the cause of leaving the air on a spiral fault panel and remains off until maintenance personnel arrive.

The integrity of the proposed self-monitoring automatic FM transmitter would be maintained by maintenance personnel visiting the transmission site once each week and checking the calibration of the various sensors and level detectors and verifying the accuracy of the self-monitor circuits.

Remote Controlled Studio Camera

Another interesting development in the field of program production is the remote controlled television camera. This camera and its associated equipment can be rotated on both a horizonal and a vertical axis while the camera lens can be pre-set or varied throughout its focal range, all from within the studio control room. One control room operator can have the simultaneous control of up to four of these cameras. In actual use, no cameraman is needed.[106] The camera is capable of two operational modes. One mode of operation uses the preset principle which permits rehearsals of exact shots before the program begins. As the director decides which camera shots he will need, each shot is pre-set. When the action begins, the director has but to press a single button to select each of the individual preset shots. Another mode of operation puts the remote camera operator, or perhaps the director, at a set of control handles. Through manipulation of these control handles, the camera may be turned on each axis or the lens may be altered to suit shot needs.

Remotely controlled cameras have immediate advantages. By the elimination of cameramen, production costs of live programming are lowered. This, in theory, could make more live programming possible. Remote controlled cameras are suited for newscasts, weather programs, interviews, and for carefully rehearsed production of commercials. On variety programs and musical productions, where much camera movement is desired, the standard studio camera with its attendant cameraman will no doubt continue to be used because in any creative program situation a skilled cameraman is a necessity to assist with the anticipation of program action and the set-up of shots.

Automatic Check-out of Color Television Cameras

Modern color cameras require a large amount of maintenance-technician time to set up and align. Each channel of the color cameras must be precisely aligned with all others to maintain changing scenic

---

[106] Autocam Brochure (New York: Television Zoomar Company, 1965), p. 1.

conditions, such as varying light levels and lens-zooming operations. The time consumed for alignment and set up can range from thirty minutes to more than an hour, and often requires two men.

A "go, no, go" system check-out, such as is often used in certain military electronic systems, is not desirable for camera check-out. Color camera set-ups require a certain amount of artistic talent on the part of the operator since the final camera performance is basically qualitative. Because of this qualitative aspect, Eric Herud, of Philips Broadcast Equipment Corporation, reports that his corporation believes that a complete automated "check out" system is impractical. He says, "Even if we could assume feasibility, the cost and complexity of such a device would make its use prohibitive."[107]

The Philips Corporation has made an attempt to provide what they consider a practical solution to the problem. First, as has been the case with most manufacturers, their camera circuits are being constructed so as to make them inherently more stable. Secondly, they have designed a semi-automatic checkout of camera circuits. This system operates on the basis of three steps.

1. Station personnel initially set up and align cameras.
2. A sampling process is then used to record on storage tape all key voltages and values of various oscilliscope wave patterns. This information constitutes a memorized standard for the camera circuits.

---

[107] "What the Experts Predict," Broadcast Management/Engineering, III (September, 1967), 9.

3. During future checkouts, an electronic comparison is made of the camera's performance against the memorized standard. Only circuits out of tolerance would require readjustment.[108]

This equipment is not yet commercially available. The advantages of such systems, however, will probably be sufficient to prompt widescale demand, particularly in view of the fact that the same type of system could be employed to rapidly check out virtually all of the studio equipment in large studio complexes.

Centralized Data Processing

Trends in other American industries forecast the fact that group stations which are owned and operated by an individual or corporation may be able to achieve a high level of efficiency from an automation central. This approach assumes a central point, fully equipped with computerized office equipment. This point would be linked to each individual station within the group by use of data communication lines such as those currently available from American Telephone and Telegraph Company. The central control point could then be responsible for all of the individual station's scheduling, billing, accounting, and perhaps even the automatic typing of the daily program log.

The Cox Broadcasting Corporation is one company which is reportedly contemplating data inter-communication lines between its stations and other enterprises to an already existent central processing point. Interconnection is expected to cost approximately $4,000 per

---

[108] Ibid., p. 29.

month. In this case, no doubt, the Cox Corporation will find new frontiers in more efficient uses of its equipment. On this subject, one Cox Broadcasting executive stated that his corporation "looks forward to the day when a group broadcaster can adopt a complete management control system for all stations within their group."[109]

It seems entirely possible that the small stations, which for justified economic reasons are prevented from owning or leasing computerized data processing equipment, may eventually find hope in other quarters. These electronic data processing services might be provided by private companies, many of whom are already servicing certain segments of American industry. The telephone directory's yellow pages or other advertising media in any medium-size metropolis contain listings of area-wide data processing companies ready to cater to businesses of any size such services as payroll computations, cost accounting, and other functions which are applicable to electronic data processing. Some of these companies are already specialized in their services, including statement writing and accounts receivable for groups such as physicians and dentists. Therefore, it is entirely plausible that some broadcasters, too, may turn to such private companies to handle their specialized needs.

Conclusions

Today's technological marvels are only forerunner of the products which the wizardry of science will bring forth in the next decade. Technological advancement is by nature exponential in scope, for each new

---

[109] Ibid.

achievement may give rise to dozens of others. If the past can mirror the future, then the American marketplace will continue to yield new and more efficient ways of accomplishing industrial tasks.

For those who are in the broadcast industry, it is much too late for debate over the virtues of technological advancement. To so argue would be to deny the fact that the entire broadcasting industry was born out of technological advancement. Likewise, automation is a product of technological advancement. It currently knocks loudly at the broadcasting industry's door. Automation's impressive success story in other American industries offers assurance that the broadcasting industry door will be opened. In pondering the consequence of this trend, successful broadcasters are ceasing to ask yesterday's question, "Shall I automate?" Instead, the cogent question of today is, "How much shall I automate?" For those who earnestly seek the "golden mean" of broadcast automation, three admonitions bear consideration.

First, an extremist position should be avoided. There are broadcasters who through unawareness and perhaps apathy are comfortable with the present and consider themselves insulated from changing trends. Some others suffer from what might be referred to as the "hardware syndrome." The latter are prone to view equipment as an end unto itself, an almost magical panacea for station problems. In their haste to be first in the purchase of new and more complex equipment, they very likely ignore the danger that the solution to a problem may be more complex than the problem itself or that automation does not belong in an area where a more efficient, less expensive solution is available.

A second important admonition is to remember that automation involves far more than technical decisions. At the 1968 National Association of Broadcasters Convention and Engineering Conference, George H. Brown, executive vice-president of Research and Engineering of the Radio Corporation of America, urged broadcast engineers to re-orient themselves away from being equipment-minded engineers to becoming systems planners. He continued:

> And when I say systems here, I mean the broadcasting systems . . . extending from the advertiser's order form to the audience living room.[110]

Finally, and most obvious of all, is the fact that automation is so potentially inclusive in scope as to be a way of business. Any decision-making regarding its use must be based on an analysis of a station's economic, social, programming, and technical circumstances. Such a comprehensive analysis can come only from management. In the interest of good business, far-sighted management will manifest a high level of involvement in any trend toward automation. Every step will be coordinated and supervised, from feasibility study to equipment utilization. It is to this group of managers that the promise of automation will continue to shine most brilliantly.

---

[110]"NAB Convention 1968--Convention Highlights," Broadcast Engineering (May, 1968), 20.

BIBLIOGRAPHY

BIBLIOGRAPHY

Books

Ahrendt, William R., and Tuplin, John F. Automatic Feedback Control. 1st ed. New York: McGraw-Hill Book Company, 1964.

Beaumont, Richard A., and Helfgott, Roy B. Management, Automation and People. Brattleboro, Vermont: The Book Press, 1964.

Becker, Esther R., and Murphy, Eugene F. The Office in Transition--Meeting the Problems of Automation. New York: Harper and Brothers, 1957.

Brady, Robert A. Organization, Automation and Society. Berkeley and Los Angeles: University of California Press, 1961.

Bretz, Rudy. Techniques of Television Production. New York: McGraw-Hill Book Company, Inc., 1962.

Brozen, Yale. Automation: The Impact of Technological Change. Washington: American Enterprise Institute, March, 1963.

Buckingham, Walter. Automation: Its Impact on Business and People. New York: Harper and Brothers Publisher, 1961

Chester, Giraud, and Garrison, Garnet R. Television and Radio. New York: Appleton-Century-Crofts, Inc., 1956.

Cubbedge, Robert E. Who Needs People? Washington: Robert B. Luce, Inc., 1963.

Cushman, Edward L., Somers, Gerald G., and Weinberg, Nat (eds.). Adjusting to Technological Change. New York: Harper and Row, Publishers, 1963.

Greenberger, Martin (ed.). Management and the Computer of the Future. New York and London: M. I. T. Press and John Wiley and Sons, Inc., 1962.

Kennedy, Thomas, and Plaut, Frank D. Automation Funds and Displaced Workers. Boston: Harvard University, Division of Research, Graduate School of Business Administration, 1962.

Laird, Donald A., and Laird, Eleanor C. How to Get Along with Automation. New York: McGraw-Hill Book Company, 1964.

Lilley, S. Automation and Social Progress. New York: International Publishers, Inc., 1957.

Littlefield, C. L., and Peterson, R. P. Modern Office Management. Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1956.

Markham, Charles (ed.). Jobs, Men and Machines: Problems of Automation. New York: Frederick A. Praeger, Publisher, 1964.

Peschon, John (ed.). Disciplines and Techniques of Systems Control. New York: Blaisdell Publishing Company, 1965.

Stasheff, Edward, and Bretz, Rudy. The Television Program. New York: Hill and Wang, 1962.

Walker, A. Prose (ed.). NAB Engineering Handbook. New York: McGraw-Hill Book Company, Inc., 1960.

Public Documents

U. S., Bureau of Labor Statistics. Employment and Earnings Statistics for United States, 1909-1967, Bulletin No. 1312-5 (October, 1967).

U. S., Congress. Hearings. Subcommittee on Economic Stabilization of Joint Committee on the Economic Report. "Automation and Technological Change." 1955.

U. S., Congress, Joint Economic Committee. News and Views on Automation, 86th Congress, 2nd Session, Report 1152.

U. S., Federal Communications Commission. Federal Communications Commission Reports. Decisions and Reports of the Federal Communications Commission of the United States, Vol. XXIII, Docket No. 10214, July 12, 1957. Washington: U. S. Government Printing Office, 1959.

Reports

Clark, Don W. Automatic Programming and Logging. A Report to the 1965 NAB Broadcast Engineering Conference, March 21-24, 1965, Washington, D. C.

Coulthurst, Danny. "Broadcast Automation--Past, Present, and Future." A Report to the 1965 NAB Broadcast Engineering Conference, March 21-24, 1965, Washington, D. C. (Mimeographed.)

Planning for Automated Radio Programming. A Report prepared by the Automatic Tape Control to the 1965 NAB Broadcast Engineering Conference, March 21-24, 1965, Washington, D. C.

"Prolog" Automatic Programming and Logging for AM or FM. A Report by the LVT Continental Electronic Division of Ling-Temco-Vought, Inc., to the 1965 NAB Broadcast Engineering Conference, March 21-24, 1965, Washington, D. C.

"Visual 12,000 Audio Automation with IBM Punch Card Control." A Technical Paper prepared by the Visual Electronic Corporation for the 1965 NAB Broadcast Engineering Conference, March 21-24, 1965, Washington, D. C.

Unpublished Materials

Griese, Ralph. "An Approach to the Human Problem in Systems Mechanizations." Unpublished Master's thesis, College of Engineering, Michigan State University, 1959.

Articles and Periodicals

"Ampex Looks into Its Ranks for Leadership," Broadcasting (December 25, 1967), 73.

"Automated Video Switching," Broadcast Management/Engineering, III (September, 1967), 33-40.

"Automation from Program through Billing--1967 NAB Convention Report," Broadcast Engineering (May, 1967), 43.

Barden, William. "High-Speed Punched-Card Readers," Electronics World (January, 1967), 43.

Buffington, Charlie. "Automatic Program Control: Theory and Operation," Broadcast Management/Engineering, II (September, 1966), 22.

_______. "Unattended Programming in Action," Broadcast Management/Engineering, II (September, 1966), 28.

"Data Processing," Broadcast Management/Engineering, III (September, 1967), 43.

"Does T. V. Automation Pay Off?" Broadcast Management/Engineering, I (February, 1965), 32.

"Editorial," Systems, VI (March, 1965), 9.

"EDP Boom Keeps Rolling Along," Business Automation (January, 1968), 42.

Etkin, Harry A. "Unattended UHF-TV Transmitter Operation," Electronics World (January, 1967), 32.

"FCC Approves Digital Meters for Transmitters," Broadcast Management/Engineering, III (November, 1967), 8.

Finnegan, P. S. "Station-Break Automation for Television," Broadcast Engineering, VIII (February, 1966), 12.

"Focus on Automation," Broadcast Management/Engineering, I (September, 1965), 27-43.

Hasket, Thomas R. "Audio Tape Equipment," Broadcast Engineering (February, 1965), 18.

________. "Automation at the Transmitter Site," Broadcast Engineering (June, 1965), 10.

________. "Audio Tape Equipment," Broadcast Engineering (December, 1964), 30.

________. "Audio Tape Equipment," Broadcast Engineering (January, 1965) 14.

"How Good Is Automated Radio?" Sponsor/U.S. Radio (March 26, 1962), 66.

"Impact of Automation," Monthly Labor Review, Bulletin No. 1287 (November, 1960), 21.

"Interpreting the FCC Rules and Regulations," Broadcast Management/Engineering (April, 1966), 13.

Jones, Robert A., and Markley, Donald L. "Antenna Patterns by Computers," Broadcast Engineering (March, 1967), 21.

Kornblum, Richard D. "Editorial," Business Automation, XII (March, 1965), 76.

Lovell, Ross W. "The Nature of EDP," University of Houston Business Review (1964), 4-5.

"NAB Convention 1968--Convention Highlights," Broadcast Engineering (May, 1968), 20.

"NAB Report," Broadcast Engineering (May, 1967), 57.

"Remote Control of TV Transmitters," Broadcast Management/Engineering, I (July, 1965), 41.

"Self Monitoring of Automatic FM Transmitters," Broadcast Engineering (September, 1967), 42.

Smith, Edgar C. "An Automatic Programming and Logging System," Broadcast Engineering (October, 1964), 12.

Smith, J. L. "What the Experts Predict--Man and Machine," Broadcast Management/Engineering, III (September, 1967), 28.

Tong, Edward. "An Automatic Program Logger," Broadcast Engineering (October, 1964), 12.

"Video Switching," Broadcast Management/Engineering, III (December, 1967), 27.

"What the Experts Predict," Broadcast Management/Engineering, III (September, 1967), 9.

Brochures

Autocam Brochure. New York: Television Zoomar Company, 1965.

Automatic Program Control System, APC-101, brochure of Central Dynamics, Ltd., 147 Rymus Boulevard, Pointe Claire, Quebec, 1965.

Brochure of Hancock Telecontrol Corporation, 143 Sound Beech Avenue, Old Greenwich, Connecticut.

Brochure of Sarkes Tarzian, Inc., Bloomington, Indiana.

RCA New Look. TV Systems Demonstration at 1965 NAB Convention, Washington, D. C. Form 3j4871-Tmk(s).

TASCOM Traffic Availabilities Scheduling Computer. Bloomington, Indiana: Sarkes Tarzian, Inc., 1965.

"The Development and Theory of Magnetic Tape Recording," Ampex Manual (October, 1959).

TRAFFACCOUNTING for Broadcasters. TRAFFACCOUNTING Accounting and Data Processing Company, Denver, Colorado.

"Visual's Activities Grow in Providing Facilities for Diverse Educational Television Systems," VISUAL VIEWS of the Broadcast Industry (February, 1967).