

A STUDY OF THE POSSIBILITY OF COMPUTERIZING
VARIOUS MOVEMENTS TO COMPOSE A PROPER
ROUTINE ON PARALLEL BARS

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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS

I. INTRODUCTION

The desire and the ability to use mechanical devices has long been a human characteristic. Since the development of the modern electronic computer a scant few decades ago, the computer has risen from a laboratory toy to an industrial and scientific necessity. Computers today perform complicated scientific calculations to keep track of a satellite, prepare electric and telephone bills, make train and airplane reservations, balance bank accounts, write salary checks, and do thousands of other difficult tasks.

In education, the computer has been utilized in registration and scheduling, attendance procedures, grade reporting, composite and permanent student records.¹ The continuous search for new scientific devices to aid in the effective teaching of sport skill is one of the important elements of today's educational system; for example, by the careful examination of the repeated performance of

¹Donald K. Sharpes, "Computers in American Education," The Clearing House, (November, 1968), 135.

an expert in an 8mm loop film, a beginning student can acquire a knowledge and understanding of fundamental techniques in gymnastics. Further examples of teaching devices would be slow motion movies or instant playback in closed circuit television enabling the student to analyze the performance step by step.

While using those new devices to help teach gymnastics, the technique of composing a routine continues to follow the traditional methods. It has been known for many years that a properly connected routine would result in better performance, but there are too many alternates the computer could make a selection from the unlimited choice, a short cut leading to better composed routines on parallel bars may be reached.

II. THE PROBLEM

Statement of the problem. The purpose of this study is to investigate the feasibility of programming various gymnastic movements to enable the computer to make the selection in the composition of proper routines on the parallel bars.

Importance of the study. The parallel bars is an event in gymnastics which consists of many components; the

variation of movements is comparatively more complex than other events in men's gymnastics. The requirements to compose a routine on a parallel bars include swing, flight, strength, and static parts; a complete routine depends upon the coordination and smoothness in the connection of movements.

There are hundreds of ways of arrangement to be chosen when composing a routine at random; for example, in 1966-68, there were 73 movements on the parallel bars published by the United States Gymnastics Federation (U.S.G.F.). Though the routine for Class A Division was seven (7) elements,² if we consider a routine of seven different movements out of seventy-three, according to the formula on combination and permutations,³ the number of selections or combinations of different routines at a time is 1,527,072,468 different routines. No one can question the fact that physical education teachers can compose gymnastic routines manually, since they have been doing so for more than half a century. But could manual composing be as efficient as computer composing? Computerized routines may offer a number of distinct advantages for physical educators and gymnastic

²United States Gymnastics Federation, Rules for Men, (Arizona: U.S.G.F. Tueson. 1966), p. 22.

³G. A. Wentworth, College Algebra, (Boston: Ginn & Company. 1902), p. 257.

coaches:

1. Computerized routines provide a greater variety of routines which would enable physical education teachers to select the desired routine for the performers.
2. Computerized routines reduce contradictory movements in a routine, thus giving much better performance.
3. The use of computers reduces work loads for teachers in terms of composing routines and coaching, letting the teacher devote more time to teaching.

III. LIMITATIONS

Limitations of the study. First, this study was designed to compose routines from 29 selected gymnastic movements on parallel bars. The components of each routine had been limited to eight movements. Second, the electronic computer systems available at Kansas State Teachers College computer center were IBM 1401, IBM 1620, IBM 1440/1311. The IBM punch card used for this study has 80 columns, which limited the capacity of information punched in the card.

IV. DEFINITION OF TERMS

Computer. A device capable of accepting information, applying prescribed processes to the information, and supplying the results of these processes. It usually consists of

input and output devices, storage, arithmetic, and a control unit.⁴

Movements. Movements on parallel bars, which consist of swing, flight, strength, and static parts. The degree of difficulty for each movement varies from A to B to C.

Proper routine. Well connected movements between mount and dismount which fulfill the requirements of International Gymnastic Federation rules.⁵

Parallel bars. An apparatus with bars in wood, oval form, point downward vertical diameter 51mm, horizontal diameter 41mm. Height of bars 170cm. Length of bars 350cm. Inside separation from 42cm to 48cm enable performing various gymnastic movements.⁶

Swing. A movement start from cross support on parallel bars, the body move backward and forward along shoulder joints as radical center.

⁴Edith Harwith Goodman (ed.), Computer Yearbook and Directory, (Michigan: American Data Processing Inc. 1966), p. 670

⁵Code of Points, (Men's Technical Committee of the F.I.G. 1964), p. 6.

⁶United States Gymnastics Federation, Rules for Men (Arizona: U.S.G.F. Tueson. 1966), p. 13.

Flight. Movement performed above the parallel bars, on which the grip of one hand or both hands simultaneously is released.

Strength parts. Movement to be executed slowly and with strength on parallel bars.

Static parts. Movement being held still above the parallel bars with a duration of two seconds.⁷

⁷Code of Points, (Men's Technical Committee of the F.I.G. 1968), p. 20.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter examines literature and research that pertains to the history of the computer and the applications of the computer in business, industry, science, education, sports, and physical education.

I. LITERATURE ON HISTORY OF COMPUTERS

The world's first automatic digital computer, "Automatic Sequence Controlled Calculator" or Mark I, was completed in 1944 by Aiken and a team of IBM engineers at Harvard University.¹ Since that period few people can escape some contact with various computer applications such as business, industry, science, education, sports, and physical education in our society.

Calculating devices have a history that goes back to ancient China and Egypt. The first mechanical digital calculators were made by Pascal² in the seventeenth century.

¹Gordon B. Davis, An Introduction to Electronic Computers, (New York: McGraw-Hill Book Company, 1966), p. 6.

²Harrold Sackman, Computers, System Science and Evolving Society, (New York: John Wiley & Sons Inc., 1967), p. 24.

In the mid-nineteenth century, Babbage³ proposed and partially constructed an automatic machine that would carry out long sequences of calculations without human intervention. In late 1944, Aiken⁴ and a team of IBM engineers developed automatic calculators. During World War II, Eckert and Mauchly⁵ of the University of Pennsylvania developed the Electronic Numerical Integrator and Calculator, an electronic calculator. From the ENIAC came other machines, the best known of which was the Universal Accurate Computer; the first commercial computer to be placed on the market in 1954 was the UNIVAC.⁶ The Name UNIVAC was synonymous with "computer" until IBM (International Business Machines Corporation) entered the computer field. In 1953, IBM installed its first computer, the IBM 701. Late in 1954, IBM installed the first IBM 650 computer. The IBM 650 computer was the most popular computer during the next five years.⁷ Statistics⁸

³Harrold Sackman, Computers, System Science and Evolving Society, (New York: John Wiley & Sons Inc., 1967), p. 24.

⁴Gordon B. Davis, An Introduction to Electronic Computers, (New York: McGraw-Hill Book Company, 1966), p. 6.

⁵Sackman, op. cit., p. 27.

⁶Davis, op. cit., p. 10.

⁷Ibid., p. 11.

⁸Ibid., p. 507.

in 1965 showed that IBM has remained the largest supplier of electronic computers with about eighty per cent of the market. According to a report published by the American Federation of Information Processing Societies (AFIPS),⁹ there were only ten or fifteen computers at work in the United States in 1960. In 1967, there were 35,200. The rapid rise in number of computers is a result of computational devices which can do what was not possible using previously existing computational aids and the need to do data processing better, cheaper and faster.

II. LITERATURE ON APPLICATIONS OF COMPUTERS

The capabilities of computers and the impact they are having on society can probably best be understood in terms of a survey of some of the uses to which computers are being put. For purposes of this review, the uses are classified as business, industry, science, education, sports and physical education.

A. Business Applications.

In 1968, in a study of the application of computers

⁹John McCarthy, "Information," Scientific American, (September, 1967), 67.

in manufacturing lines, Dean¹⁰ completed a survey of 108 leading manufacturing companies in the United States. These companies were selected on the basis of their superior records of sales growth and return on equity compared to the averages for their industries. The companies' experiences with the computer ranged from one to eighteen years. Annual sales volumes ranged from under \$50 million to more than \$10 billion. Dean found, in the selected leading companies, that the computer is being put to much greater and more sophisticated use, and it is no longer restricted to junior management or to limited functions. The studies showed that 42% of the computer uses were in major operating areas -- marketing, production, and distribution. Eleven per cent of the uses were in research, development and engineering. Forty-four per cent of the uses were in finance and administration. Only three per cent of the use were in planning and control. About 82% of the 108 leading companies regularly prepared long-range plans to guide their computer activities. The survey clearly showed that the computer was increasingly penetrating and permeating all areas of major manufacturing corporations, and that the

¹⁰Neal J. Dean, "The Computer Comes of Age," Harvard Business Review, (January-February, 1968), 83-91.

computer was becoming an integral part of operations in those companies.

The business world was an early and extensive user of computer equipment. Business data handling requires up-to-the-minute information to fulfill the demand of the business management. In the past, managers have often avoided making cost analyses of complex problems unless the dollar stakes were large. But with the new "Terminal Costing System" developed by Mortan and McCosk,¹¹ a manager can test his hunches and experiment rapidly with different combinations of costs and prices. The terminal system combines the manipulative power of the electronic computer with the simplicity and convenience of the computer terminal, that allow the manager to interact with the cost system and then try out his own notion of volume, or check the effects of changes in prices and costs on profits.

Computers are also considered by real estate business as a useful tool. The National Association of Real Estate Boards (NAREB) recently released a report on the utilization of two IBM 360-40 computer systems to store data on style,

¹¹Michael S. Morton and Andrew M. McCosk, "Terminal Costing for Better Decision Making," Harvard Business Review, (May-June, 1968), 147-156.

price, location, special features, financing and other information on homes. It ended man-hours wasted in record keeping, freeing salesmen for greater productivity.¹² When preparing income tax bills, computers did an excellent job. There was an example in Anoka County, Minnesota, when income tax bills were prepared by computers. The County Data Processing Manager Harver¹³ reported in 1968 that, by using IBM unit record 407 data processing system, Harver and his staff programmed computer-prepared tax statements on a sealed self-mailer form in which tax data remains unseen by anyone until the taxpayer peels the sections apart. This procedure permitted tax information to be kept confidential until opened by the taxpayer. It was stated that this method cost less than previous forms and mailing envelopes. The previous job required six to ten persons and five months to handle 78,000 tax statements. Using a computer, Anoka County needed only one person to complete the entire tax run in fifteen days.

The banking industry was another early extensive user of computer equipment, as bank data requires quick, daily,

¹²News item in the Business Week, December 14, 1968.

¹³Gordon L. Harver, "No Hands Needed to Prepare Our Tax Bills," The American City, (December, 1968), 95.

and accurate processing on a gigantic scale. Computers are the only answer to a problem of this scope. Statistics¹⁴ showed that, in the year of 1967, banks in the United States had \$837 million worth of computers in use. All banks with deposits of over \$500 million were using computers, and, for those with deposits of \$100 million or more, 91% had their own computer system and another 5% used off-permise service.

Credit cards, one of the booming businesses in the American banking community, is also benefited by computers. This was an example reported by Overton, vice-president of the Texas Bank & Trust Company in Dallas. In 1967, the IBM Model 30 was used by credit clerks in the BankAmericard office. The credit clerks used typewriter-like IBM 2740 communication terminals in their office, and asked for information and received information about any active account at any time without perceptibly interrupting other work the computer was handling. The Model 30 was also programmed to print monthly analyses of activity by merchant. These showed each merchant's total BankAmericard sales by month and quarter average, ticket amount, number of applications,

¹⁴News item in Computer and Automation, February, 1967.

number of rejects, percentage of reject, and returns allowed, that enabled the bank to spot any unusual activity in merchant accounts, and then develop information of value to the merchant. The report pointed out the fact that with the aid of IBM 360, one year after the BankAmericard program started they had:

1. Issued 225,000 BankAmericards and established 100,000 accounts -- 40,000 of them active and receiving computer-printed pre-punched statements each month.
2. Signed 3,000 merchants, who generate 8,000 tickets daily.
3. Increased business to about \$20,000,000 a year gross -- enough to cover all operating expenses and assure profits in the second year, a phenomenally short period of time by most previous standards.
4. Held credit losses from all causes (non-payment, fraud, stolen card etc.) to less than 0.25% -- a rate seldom equaled in previous bank credit card start-up program.¹⁵

With the demand for computer service by some institutions which are too small to afford their own computers, many banks began to offer computer service. O'Brien in an article "Data Processing Service, Banking's New Product" revealed that these computer services included:

¹⁵Thomas N. Overton, "How a Computer Solved Our Credit Card Problem," Banking, (October, 1968), 101.

1. Computerized checking account processing to small correspondent banks. At night, encoded checks and deposit slips are transported to the computer center of the large bank and processed. These documents are returned to the small banks in the morning along with the necessary management reports.
2. Payroll Accounting. The computer provided payroll checks for employees, individual employee earning statements, a payroll journal report which shows cumulative year to date totals of each employee's gross earnings, withholding tax and social security and state unemployment insurance reports, W-2 forms for each employee and other specialized reports.
3. Professional Billing. It offers a billing and partial accounts receivable accounting service to doctors, dentists, lawyers, and certain business firms.
4. Income and disbursement analysis. In this service a bank assigns income and expense codes to the checks of certain customers and then produces a monthly income and distribution report for these customers.¹⁶

The application of computers in business is expanding everyday; this review has presented just a few examples of the uses that computers have in the business world. Other examples are users of computers in the Federal Government, the Department of Defense, the Treasury Department, and

¹⁶James A. O'Brien, "Data Processing Service, Banking's New Product," Computer and Automation, (October, 1968), 40.

the Social Security Department. Some of the applications mentioned are established and used as a matter of routine and some are experimental, but all are being used with success and with a result of saving time and man power.

B. Industrial Applications.

The reduction and elimination of human labor through ingenuity and mechanical devices has been going on for thousands of years. Automation has not only released more of men's time and energies for other pursuits, it has led to unmatched material prosperity and increasingly better use of natural resources. Among those mechanical devices in the field of automation, the electronic computer has played an important role. Since the application of the computer entered the world of industry, it has been credited as one of the main powers involved in the second industrial revolution.¹⁷

The computer revolution also started a new era of automation. Of course, automatic control does not necessarily require a computer; for years simple controls have run everything from a home furnace to an airplane. But a

¹⁷Dennis Flanagan (ed.), Automatic Control, (New York: Scientific American Inc., 1955), p. 26.

computer does more than monitor a single stage in a process. It can "collect hundred of measurements, compute what effect such will have on the final output and set the control to the best results."¹⁸ Some examples of the computer users in industry are the glass industry, paper industry, automobile industry, petroleum refining, cement producing, fishery predicting, and plant and warehouse locating.

Early in 1965, an Owens-Corning Fiberglas Corporation employed an IBM computer control system to control the furnaces. The computer controlled the furnace by detecting changes at a wide range of measuring points in and around the furnace. The computer scanned the signals from thermocouples and other sensing devices at predetermined times. One crucial instrument was read ten times every second; another instrument was sampled only once every minute and a half. The computer analyzed the readings to spot any deviation from established set points that would affect the quality of the glass. It then determined what changes would serve best to bring the readings back into an acceptable range and signaled the appropriate valve or lever to

¹⁸Carl Behrens, "On The Production Line," Science News, (December, 1967), 539.

make the adjustment. With installation of computers, the company found results as follows:

1. The system makes possible 50% cost saving compared to other methods.
2. The stability of temperature was improved 60% by the system's high accuracy.
3. The product became markedly more uniform because of the tighter control of variables in the process.¹⁹

A similar improvement in the glass industry after using a computer to control production was reported by Behrens of Ford Motor Company's Glass Division in 1967:

With a computer system operated at the Ford Company's Glass Division, less strain is placed on furnaces and other equipment. Temperatures in the 2,000 degree F. range can be controlled to within one degree, and pressures in the furnace can be held to within two thousandths of an inch of mercury. These tolerances were up to five times tighter than in the past.²⁰

The control of paper machines is a good example of an application in which the computer can deal with a large amount of information, monitoring the many variables involved in such a way as to maintain optimum production and quality of a product in the paper industry. Coon in a

¹⁹"New Edge in Glass," Business Week, (April 10, 1965), 62.

²⁰Carl Behrens, "On The Production Line," Science News, (December, 1967), 539.

study, "The Uses of Computers in Technology," revealed that a paper machine at the Mead Corporation's Kingsport Division in Tennessee uses an IBM 1710 computer control system to monitor the process and directly control one of the important variables, the average "basis weight" in the total processing. A mixture of wood pulp, water and additives emerges from the headbox, is spread on a wire screen and carried through pressing and drying operations. The basis weight is measured by a beta ray gauge, the computer reports any variations from the desired standard, warns the operators and computers and initiates corrections in the flow rate of materials at the headbox. With the control of the IBM 1710, the 405-foot-long machine produces rolls of paper up to 16 feet wide at the rate of 2,000 feet per minute, which is much better than the previous methods.²¹

Another interesting variation of computer usefulness was reported by Mathews of the University of Washington. This was a simulated performance of the sockeye salmon runs to Bristol Bay, Alaska, over 100-year periods, which is considered one of the greatest contributions to the fishery

²¹Steven Anson Coons, "The Uses of Computers in Technology," Scientific American, (September, 1966), 178.

and canning industry.²² The IBM 709⁴ forecast the runs of salmon to each river which enabled both efficient preseason investment and optimum management of the fishery; the benefits margin averaged \$1,000,000 to \$2,500,000 more than with no forecast. In his simulation study a fleet of 350 boats was optimal; with this small sized fleet an accurate forecast of the total run added \$1,200,000 to net yield, and accurate river-system forecasts added \$5,000,000.²³

In the automobile industries, computer graphics have been attracting the auto designer for quite some time.²⁴ The computer's fast output, plotting capability, and new forms of input certainly result in improved man-machine communication. Ford Motor Company recently installed the Control Data Corporation 27⁴ display. The system had a screen of over 300 square inches and a 4,000 x 4,000 inches resolution matrix. It can approach 20,000 vector inches of information on a flat distortion-free tube face. The Ford

²²Stephen Barstow Mathews "A Computer Simulation Study of The Potential Benefits to A Salmon Canning Industry From Accuration Forecasts Of The Runs," Doctoral Dissertation, University of Washington, 1967.

²³Ibid.

²⁴Walter L. Johnson, "The Ford Computer Graphics Project," Computer and Automation, (November, 1967), 35.

engineers use these devices to analyses programs, such as kinematic linkage analysis, review the computer output to check interferences, torque and acceleration studies. Another area for applying a computer was numerical control of machine tools.²⁵ Since the Ford Company has successfully applied computers in the auto industry, more and more auto producers are moving into this area. A study by Berkwitt in 1968 showed the increasing demands of computerized processing in the auto industry, ". . . as Detroit tried to satisfy increasing demands for custom styling of everything from hubcaps to engines. It has been estimated that sales of on-line computers to the auto industry will jump from the present \$4 million to well over \$17 million with in five years."²⁶

Some other areas that seem ready for automatic computer control as shown in Berkwitt's study are:

1. Petroleum refining: In Spring 1967, Mobil Oil completed the pilot phase of a project to centralize control of its 351-well Pegasus oil field in Midland, Texas. It was the first use of a computer to control operation over an entire oil field. Pegasus yields 15,000 barrels of oil, produces 7,5000 barrels of liquid by-products and processes 75 million cubic feet of gas a day.

²⁵Ibid.

²⁶George J. Berkwitt, "March of The Blue-Collar Computers," Dun's Review, (January, 1968), 66.

2. Cement: A closed-loop kiln control system at Dandee Cement Co. of Dundee, Michigan, says the company has upped cement production 5%, reduced fuel 4% and cut maintenance costs, always heavy in cement making. An advanced system is operating at Ideal Cement's modern plant in Tijeras, New Mexico.
3. Metals: In 1968, there were about eighteen major installations in the basic metals industry. Applications vary, running from control of arc, basic-oxygen and blast furnaces to control of hot strip and foundries.²⁷

In the area of locating plant and warehouse facilities, which is an important long-range planning problem for industrial management, the computer's capacity for speed and accuracy have been utilized. One of the major obstacles which has restricted the application of operations research techniques is the difficulty of measuring the added benefits derived. There have been few situations in which both a conventional and operations research analysis have been conducted in parallel in such a way that the recommendations resulting from the two approaches could be compared on a consistent basis.²⁸ A recent application of a computer by a large nation wide manufacturing corporation made such a

²⁷Ibid, p. 67.

²⁸Robert J. Atkins and Richard H. Shriver, "New Approach to Facilities Location," Harvard Business Review, (May-June, 1968), 70.

comparison possible. In this particular study, the computer was used in the analysis; by a series of straightforward economic comparisons, the computer eliminated most of the alternatives, then evaluated the remaining ones in a way that quickly led to the best solution. With the application of the computer in making decisions on facilities location, Atkins and Shriver found two significant:

1. The computer saved time: The problem solved manually may need four man-months.
2. The computer save money: The results were twice the savings of the solution arrived at manually.²⁹

C. Scientific Applications.

In its scientific applications the computer has been noticed in two quite distinct but complementary roles: as an instrument and as an active participant in the development of scientific theories. The role of the computer as a research instrument can be readily understood by referring to Perutz's work, "The Hemoglobin Molecule," in which a computer was used as a chain from raw observations to X-ray crystallography.³⁰ After finishing the structure of

²⁹Ibid, p. 78.

³⁰M. F. Perutz, "The Hemoglobin Molecule," Scientific American, (November, 1964), 70.

the hemoglobin molecule, Perutz did admit ". . . such a task would have been quite impossible before the advent of high-speed computers."³¹ The determination of protein structures by Kendrew in 1961 provides an excellent example of the computer acting out the implications of a theory.³² The remarkable immediacy and clarity of the confrontation of acted-out theory and experiment by computer shown in the preceding example is by no means an isolated phenomenon. Similar techniques are emerging in hydrodynamics, in chemistry and in other branches of science.

The fundamental behavior of fluids has traditionally been studied in tanks and wind tunnels. The capacities of the modern computer make it possible to perform subtler experiments on the computer alone. As early as 1965, Harlow and Fromm utilized an IBM 7090 computer to design a basic computing mesh for a mathematical wind tunnel. It consisted of a grid of 1,176 individual cells, arranged in rows 49 cells long and 24 cells wide. The obstacle, twice as high as it is deep, was located 12 cells away from the input flow at the left margin of the mesh. At the start of an experiment each cell was programmed with a minimum of two numbers, which

³¹Ibid.

³²John C. Kendrew, "The Three-dimensional Structure of Protein Molecule," Scientific American, (December, 1961), 96-11

represented the horizontal and vertical components of the average air velocity at the point in space. During the run of an experiment, the computer carried out billions of mathematical operations to determine the flow.³³ In addition, the computer itself can generate plots of the flow configurations and put them on film by means of a microfilm recorder. Harlow and Fromm also found that "Experiments with numerical models can show the interaction of winds and a bridge in detail and produce answers in far less time than it takes to prepare a physical experiment."³⁴ Some other benefits of a computer experiment included:

1. Solving the problem of measuring temperature directly in a wind tunnel in a complicated downstream wave. Computer experiment usually affords better control of the experimental conditions than is possible in a physical experiment.
2. Experiments by computer provide a test of the applicability of theory to the complicated phenomena under investigation and help mathematicians to obtain the kind of exact solution that can be obtained by the processes of mathematical analysis.
3. The detailed results provided by a computer can actually help in development of analytical solution of the basic equations of fluid dynamics.³⁵

³³Francis H. Harlow and Jacob E. Fromm, "Computer Experiments in Fluid Dynamics," Scientific American, (March, 1965), 104.

³⁴Ibid. p. 105.

³⁵Ibid.

On September 1965, Harlow, Shannon, and Welch conducted a similar experiment at Los Alamos Scientific Laboratory, Los Alamos, New Mexico. The investigators used an IBM 7030 computer to illustrate a new technique for numerically solving problems in fluid dynamics. The liquid waves generated by the computer through a succession of small time steps or cycles resembling the frames of a motion picture have been compared with experiments "showing excellent agreement in every case."³⁶ Some other advantages of computer use to study liquid waves were found as follows:

1. The computer gives more detailed data than can be obtained from experiments.
2. Computer studies often provide a valuable basis for analytical studies of physical process, giving both new ideas for models and a base for comparing the results of analysis of the models.³⁷

In the same year, literature on application of computers in chemistry was also found in Science News Letter. The report stated that a computer system in Chemical Abstracts Service of Columbus, Ohio, has been programmed to file thousands of names of known chemical compounds. Therefore, the computer can tell whether a certain compound is new or not by comparing it with those already listed. Also, the system can

³⁶Francis H. Harlow, John P. Shannon, and J. Edid Welch, "Liquid Waves By Computer," Science, (September 3, 1965), 1903.

³⁷Ibid.

be used to locate all the compounds having certain characteristics. The system helps the Chemical Abstracts to summarize and index reports on progress in laboratory research and engineering development in all parts of the world.³⁸

Computers were also used in the field of cardiac research with significant results. In 1965, in research conducted by Topham of the University of Utah, a computer was programmed to calculate the time course of heart rate, mean pressure, stroke volume, cardiac output and resistance. He found that "The analog computer model was able to predict the time course of treadmill speed and has provided insight into future research which must be done to fully describe the system."³⁹ In New York, Gertler used a computer to predict those persons who would suffer from heart attacks. He fed into the computer facts about the patient, such as his body build, family medical history, and the condition of his blood. The computer then can with a "high degree of accuracy" help a doctor tell if a person is likely to have a heart attack.⁴⁰ In 1968, with the purpose of giving

³⁸Science News Letter, (June 12, 1965), 372.

³⁹William Sanford Topham, "Control of Cardiac Output Studied With Computer Techniques," Doctoral Dissertation, University of Utah, 1965.

⁴⁰Alfred Lewis, The New World of Computers, (New York: Dodd, Mead & Company, 1965), p. 54.

cardiologists and allied professionals an overview of current practices in computerized electrocardiograph, a conference on computer capability to interpret the electrical activity of the heart was presented to a group of 250 cardiologists in Washington D.C. The meeting was attended by physicians concerned with the shortage of specialists to read electrocardiograms and the growing demands for high-quality medical services. According to the seminar report, Stewart noted that he had had an on-line computer interpret electrocardiograms with success during the preceding year. Brody of the University of Memphis illustrated that he investigated how an electrocardiograph can work with a computer via a light pen. He had used this machine for two years.⁴¹ These reports seem to indicate the possibility of using a computer to solve the manpower utilization problems that exist in the shortage of electrocardiogram specialists today.

D. Educational Applications.

The use of automatic data processing equipment as a tool in education is expanding rapidly. This expansion is being accelerated by the contacts that educators have with state departments of education and institutions of higher

⁴¹C. A. Caceres, "Computers in Clinical Electrocardiograph," Datamation, (January, 1968), 57.

learning making effective use of the equipment. In a book, Automatic Data Processing In Education, Whitlock stated that in September 1957, there were thirteen state education departments haveing automatic data processing installations. By 1962, 45 state education departments had installed this equipment.⁴² At least eight hundred school districts in the nation made some application of Automatic Data Processing during the school year 1961-62.⁴³ The majority of the cases show equipment was used in business accounting and student accounting operations in such areas as employed personnel, pupil personnel, school finance, curriculum, and research and information services.⁴⁴ The school districts in California use computers to do jobs such as business accounting, attendance accounting, grade reporting, census, permanent records, registration, scheduling, and some other statistics applications.⁴⁵ As for the effects of the installations of computers in educational service, most of the results turn out to be encouraging.

Early in 1964, with the purpose of examining the effect of the installation of Automatic Data Processing (ADP)

⁴²James W. Whitlock, Automatic Data Processing In Education, (New York: The MacMillan Company, 1964), p. 4.

⁴³Ibid.

⁴⁴Ibid. p. 5.

⁴⁵Ibid. p. 3.

procedures on the administrative and educational services in New England public schools, Greenhalgh conducted a survey by means of questionnaires and interview, and found ADP did generate more data with greater speed and accuracy than the preceding manual system. Fourteen of twenty interviewees stated that the amount of teacher time formerly devoted to clerical tasks had been considerably reduced due to the introduction of ADP.⁴⁶

Wogaman of the University of California found a similar result after he examined and analyzed the impact which the introduction and use of educational Data Processing had in the Bay Area secondary school.

Wogaman stated:

1. The Automatic Data Processing had provided a substantial reduction in the overall clerical workload of the local school. The major beneficiaries of this reduction were the teachers, who were spared many clerical routines, especially in connection with grade reporting.
2. The overwhelming mass of staff members were highly favorable in their opinion of ADP.⁴⁷

On the East Coast, Brummit studied the impact of a

⁴⁶John Greenhalgh Jr., "The Effect Of The Installation Of Automatic Data Processing Equipment On The Administrative and Educational Services In New England Public School System," Doctoral Dissertation, The University of Connecticut, 1964.

⁴⁷Thomas D. Wogaman, "Data Processing: Its Introduction And Use In Secondary School," Doctoral Dissertation, University of California, Berkeley, 1965.

machine data processing system on the central schools of New York State.

Brummit found:

1. The work of teachers has been significantly reduced in the application of attendance and grade report.
2. Automatic Data Processing had a positive effect on staff morale.
3. The greatest effects were apparent in the pupil attendance, scheduling, testing and grade reporting.⁴⁸

Other studies on the applications of computers in schools include Donald's research on some New Jersey public schools utilizing computers in scheduling for the school year 1963-64, and Dulin's study of the use of electronic data processing in school transportation systems in 1966. Donald found that the computer scheduling system was considered by the administrators to be more efficient than manual sort, needle sort, and machine data processing which were previous systems used in the New Jersey public schools.⁴⁹

Dulin used an IBM 1620 computer in designing school transportation systems in which he found that the computer

⁴⁸Bruce R. Brummit Jr., "The Impact of Machine Data Processing System On The Central Schools Of New York State," Doctoral Dissertation, Syracuse University, 1965.

⁴⁹Wright R. Donald, "Computer Scheduling In Selected Secondary Schools In New Jersey," Doctoral Dissertation, Rutgers-The State University, 1965.

has more workable input data for the actual generation of the bus routes; it could consider more bus stop combinations in determining the best routes than could feasibly be considered in the manual method of designing routing systems.⁵⁰

Computer-Assisted-Instruction (CAI) is another important aspect of the computer in education, in which the computer is closer in character to such familiar administrative functions as routine record-keeping and accounting. The introduction into educational systems of the computer and of the wide variety of associated electronic and mechanical teaching devices, together with entirely new programmed instructional material, presents for the first time entirely new opportunities to deal effectively with educational problems. Computers enable schools to offer a type of individualized instruction geared to the backgrounds and experience of each student in a way that has never previously been possible. Evidences of CAI programs include mathematics, chemistry, and languages.

Experiments for computers in arithmetic at the elementary level were described in a survey on the use of computers in education done by Suppers of Stanford University in 1966. Suppers used IBM visual devices on which the student can view

⁵⁰James T. Dulin, "The Use Of Electronic Data Processing In School Transportation System," Doctoral Dissertation, The University of Mississippi, 1966.

displays brought up from the computer memory. Another device is the cathode ray tube, that enables messages to be generated directly by the computer on the face of the tube. The ray tube was mounted with a typewriter keyboard, which the student can use to respond to problems shown on the screen. The computer program covered 48 concepts, laws of arithmetic, and some computative problems. By the last day of a six day period study, student responses were more than ninety per cent correct and the speed of reply was twice what it was at the start.⁵¹

Charp, director of instructional system for School District of Philadelphia, recently reported that "Project Crow", a computer-assisted-instruction (CAI) system now operating in Philadelphia, is successfully providing individualized instruction in reading for students of three secondary schools. The students use computers which consist of television-like screens, keyboards and lightpens. When the student signs in at his terminal, the computer displays the specific work prescribed for that student. The student reads the textbooks and books at the accompanying illustrations, and answers the questions. The student can either type an answers or touch the lightpen to an activated portion of the screen to select an answer. Then he is given other material

⁵¹Patrick Suppers, "The Use Of Computers In Education," Scientific American, (September, 1966), 217.

according to the response he made. Charp commented on the CAI reading program as follow:

1. The CAI program presents just one problem at a time. Students who are easily frustrated by a book, or even a sheet of exercises, drill readily at a computer terminal, because they just handle one question at a time.
2. The students are encouraged by success and not too frustrated by mistake.
3. The teacher is freed to devote his attention to the other students in the classroom.⁵²

In Salem, Oregon, various computers were used in computer instruction by more than thirty high schools in the field of teaching basic understanding of computers as problem-solving tools and to help students become aware of future changes in society that computers and automation will bring.⁵³ The reaction of students revealed mostly enthusiasm; some students from Serra High School in Salem, Oregon, gave up their weekends because at that time one of the computers was available. Some eager Dallas High School teenagers even spent their spring vacation writing a program for a small computer at their school.⁵⁴

CAI in higher learning seems more practical than that

⁵²Sylvia Charp, "Computer-Assisted-Instruction In Reading," Scholastic Teachers, (May 2, 1968), 14.

⁵³Bud R. Pembroke, "Computers In The Classroom," Scholastic Teacher, (May 2, 1968), 4.

⁵⁴Ibid. p. 14.

used in high schools. Computers at the University of Illinois are used as chemical analysts, and computers at the University of Kansas are being used to link up with a nuclear accelerator and interpret results.⁵⁵ The programmed instruction at the University of Illinois consists of a series of sequenced color slides used during an experiment in chemical analysis. The student sits at a desk-console and types written instructions to a machine that will simulate his chemical experiment step by step. A television viewer by his desk shows what is happening, there is no actual mixing of chemicals, and the equipment can be used over and over again.⁵⁶

Computer-Assisted-Instruction, the dream of only a few not too long ago, is emerging as a potentially powerful instructional tool in the nation's classrooms. Yet for all the writing about CAI, a look at programs across the country leads one to conclude that it is still in the experimental stage.

E. Sport and Physical Education Applications.

Hosinski recently investigated the use of computers in teaching the shuffin offense in basketball, and found that computer-assisted programmed instruction resulted in better knowledge and performance on the floor of the shuffin offense

⁵⁵"Nuclear Accelerator Forced Into Marriage At KU," The Gazette, (Emporia, Kansas, February 19, 1969), 3.

⁵⁶Donald K. Sharpes, "Computers In American Education," The Clearing House, (November, 1968), 43.

than learning the offense in the traditional manner.⁵⁷

Hermiston, Kozer and Montoye successfully programmed a computer to process American Association for Health, Physical Education and Recreation Youth Fitness Test results. The print-out of their particular study showed that each of the individual scores was reported in forms of percentile ranks, and also can compare with the mean, median, and standard division score. To offer this service to schools or individual teachers at the cost of about six cents per child for punching and verifying, and eight cents per child for processing the data, may help "teachers who have little time or energy left at the end of the day for routine arithmetical tasks."⁵⁸

Hermiston, in association with Faulkner, used the same technique to compute statistic scores in college physical education classes. They found that (1) The procedure was simple, economical, and applicable to programs for all ages and both sexes. (2) The method is particularly useful in the division of large numbers of children into homogeneous

⁵⁷John P. Hosinski, "An Investigation Of The Use Of Computer Assisted Instruction In Teaching The Shuffin Offense In Basketball," Doctoral Dissertation, Florida State University 1956.

⁵⁸Ray T. Hermiston, Andrew J. Kozer, and Henry J. Montoye, "Computers At The Service Of The Physical Education Teacher," Journal of Health, Physical Education, and Recreation, (September, 1968), 30.

teaching groups. (3) The computer print-outs are best used as a counseling aid to acquaint teachers with the weaknesses of students.⁵⁹

Scouts of the National Professional Football League used computers to computerize their scouting reports on 1,500 college football players.⁶⁰ In 1966 they evaluated more than 2,000 college football players before they made the final draft.⁶¹ An investigation done by Maule revealed that the Dallas Cowboys seemed to be the first team to computerize the offensive and defensive game analysis.

Worthy of notice is the essay that Noll of Bell Telephone Laboratory Inc., New Jersey, prepared for presentation at the Philadelphia Art Alliance in 1966. The computer for the first time was used in choreography. With the aid of cathode ray tube, an electronic pencil and a digital computer, Noll demonstrated a three minute movie. In the particular movie, a six stick figure under the control of the computer could rotate to any angle and be located at any position on the stage, and performed more efficiently than pencil-and-

⁵⁹"Computers and Quarterbacks," Dun's Review, (November, 1967), 63.

⁶⁰Tex Maule, "Make No Mistakes About It," Sport Illustrated, (January 29, 1968), 25.

⁶¹"Computers And Automation," Newsletter, (July, 1968), 45.

paper work in choreography.⁶² Noll further pointed out that:

The use of the computer by the choreographer in creating the ballet also solves the dance notation problem. At the completion of the ballet, all the movements of the dancers are stored within the computer in digital form. These movements could then be automatically translated by the computer into any desired form of dance notation. The dance scores would then be given to the individual dancers.⁶³

This is the only found literature on the application of computers which is close in character to the functions of computerizing gymnastic routines.

III. SUMMARY

Calculating devices have a history that goes back to ancient China and Egypt. The world's first automatic digital computer, "Automatic Sequence Controlled Calculator" or Mark I, was completed in 1944; however, the commercial computer was not available in the market until 1954. The well known computer manufacturer, International Business Machines Corporation (IBM) entered the computer field in 1955, and wrapped up eighty per cent of the market in the United States.

The application of computers in business is expanding everyday. Examples revealed in this study were their application in banking business, real estate business, credit card

⁶²A. Michael Noll, "Choreography and Computers," Dance Magazine, (January, 1967), 43.

⁶³Ibid. p. 45.

business and in manufacturing. Some other examples that exist are computer users in Federal Government, the Department of Defense, the Treasury Department and Social Security Department. Most examples in the business world are established and used as a matter of routine and some are experimental, but all are being used with success and with a result of saving time and manpower.

The computer has played an important role in industrial automation. Since the application of the computer entered into the world of industry, it has been regarded as one of the main powers which started the second industrial revolution. Most computers in industry are assigned to execute complex producing process and designing; some computers are used to do the jobs of fishery predicting, plant and warehouse locating.

Scientists have utilized computers as instruments to determine scientific theories of protein structure, the construction of hemoglobin molecule, the revolutionary method of studying hydrodynamics, and to help cardiospecialists to predict heart attacks and interpret electrocardiograms.

The use of the computer as a tool in education is expanding rapidly as well. This expansion is being accelerated by the contacts that educators have with state departments of education and institutions of higher learning making effective use of the equipment. The majority of computers used in

education are in administrative functions such as routine record-keeping, student accounting, scheduling, and grade reporting. Computer-Assisted-Instruction (CAI) is another important aspect of the computer in education. Evidences of CAI programs include mathematics, chemistry and languages, but so far it is still in the experimental stage.

Sport enthusiasts and physical education teachers found many practical uses of the computer in basketball teaching, helping the choreographer in creating ballet and solving dance notation. Some professional football coaches programmed computers to analyses offensive and defensive games. In college physical education classes, computers are serving as a valuable tool in computing statistics scores.

CHAPTER III

METHODS AND PROCEDURES

This study was designed to investigate the feasibility of programming a computer to compose various gymnastic movements into a proper routine on the parallel bars. A total of 29 movements, including four moves of mount, four moves of dismount, and 21 skills in between the mount and dismount phase, were selected to be analyzed and coded for programming.

The selection of these gymnastic movements were based upon two factors: First, it was based upon the International Gymnastics Federation requirements on performing a routine on parallel bars, such as swing, flight, strength, simultaneous release of grasp, and static parts.¹ Second, the skills selected were assumed to be performed by the United States Gymnastics Federation "Class A", Group 1, (Age 15 - 18) high school boys.² The movements were selected from the publication Code of Points of the International Gymnastics Federation (FIG), and from Manual of Badge Examination, which was published by Hong Kong Amateur Gymnastic Association.

The method of analysis of these movements was based

¹Code of Points, Men's Technical Committee of the FIG, 1964.

²Age-Group Gymnastics Workbook, The U.S. Gymnastic Federation, Arizona, 1968.

on their connective characteristic; all movements were analyzed to ascertain which movements could precede or could not precede certain other selected movements, and what movements could follow or could not follow. Then the movements were coded and punched into IBM cards for processing. The computer used in this study was an IBM 1401 system, the programming language was AUTOCODER.

I. METHODS OF SELECTING MOVEMENTS

The particular requirements on performing a routine on parallel bars are swing, flight, strength, simultaneous release of grasp, and static parts. Since most movements on parallel bars must start from a swing, few gymnasts are able to perform the static parts without showing considerable strength. If the above mentioned requirements were condensed into three categories to avoid repeat selection, there are 1. Swing and flight, 2. Static parts, 3. Parts of simultaneous release of grasp.

The movements selected in this study were assumed to be performed by United States Gymnastics Federation "Class A", Group 1, (Age 15 - 18) high school males. The degree of difficulty varied from A-parts, the basic forms of an exercise part; B-parts, being of medium difficulty; and C-parts, the

superior difficulty.³ The degree of difficulty was predetermined by the International Gymnastics Federation (FIG). The movements discussed in this chapter were selected from the Code of Points of the International Gymnastics Federation (FIG), and from Manual of Badge Examination, which was published by Hong Kong Amateur Gymnastic Association. All primary selected movements are shown in TABLE I.

³Code of Points, Men's Technical Committee, International Gymnastics Federation, 1968, p. 41-42.

TABLE I

PRIMARY SELECTED MOVEMENTS FROM VARIOUS SOURCES

-
-
1. STEMMEBACK TO SUPPORT.
DROP KIP.
UPPER ARM KIP.
STEMMEBACKWARD TO SUPPORT AND FORWARD SWING TO STRADDLE CUT.
STEMME FORWARD SUPPORT.
SWING FORWARD TO REAR VAULT DISMOUNT WITH 1/2 TURN TO FACE BACKWARD.
DOUBLE REAR VAULT BACKWARD DISMOUNT.
SALTO FORWARD TO OUT CROSS STAND.
FROM CROSS STAND BASKET TO SUPPORT.
FROM CROSS STAND FRONTWAYS AT END OF BARS, JUMP AND STRADDLE TO L SUPPORT.
FROM SUTER SIDESTAND FRONTWAYS FRONT VAULT TO FORWARD SWING IN SUPPORT.
FROM CROSS STAND SLIDE KIP TO SUPPORT.
 2. HANDSTAND, PRESS WITH STRAIGHT BODY AND BENT ARMS.
CAST TO L SUPPORT.
HANDSTAND PIVOT BACKWARD.
STEMME BACKWARD TO FREE SUPPORT SCALE.
HANDSTAND, PRESS WITH BENT BODY AND BENT ARMS.
CZECHWENDE TO L SUPPORT.
 3. STUTZKEHRE FORWARD TO FORWARD SWING IN UPPER ARM HANG.
STUTZKEHRE FORWARD TO FORWARD SWING IN SUPPORT, BODY AT LEAST HORIZONTAL.
STEMME FORWARD WITH 1/2 TURN, FEET AT LEAST AT RAIL HEIGHT.
CZECHWENDE TO FORWARD SWING.
SALTO BACKWARD TO SUPPORT.
HALF TURN FROM SUPPORT TO UPPER ARM HANG.
FROM FORWARD SWING IN SUPPORT BASKET TO SUPPORT.
CAST TO REARWARD SWING IN SUPPORT.
REAR VAULT OVER ONE BAR TO CATCH, GLIDE KIP, FRONT VAULT TO LAYBACK.
SALTO FORWARD TO UPPER ARM SUPPORT.
ROLL BACKWARD WITH GRASP TO FORWARD SWING.
-
-

II. ANALYSIS OF DATA

A. Analysis and Coding of the Movement.

The method employed for analysis of these movements was based on their connective characteristics. All movements were collected into specific groups of mount, dismount, straight arm support, and upper arm support. The moves then were analyzed to ascertain which movements could precede or could not precede other movements, and what movements could follow or could not follow the certain selected movements.

All movements which initiate the routines were coded 'M'. If the 'M' movement would initiate the routine at either end of the parallel bars, this sort of movements was coded as 'MX'.

Movements on ending of exercises were coded 'D'. Majority of the dismount movements for this study are finished with a outer cross stand position.

Movements between start and end movements were coded 'E'. The 'E' movements have been further subdivided into 'EH', 'EL', 'ES', and 'EX'. The 'EH' movements have an important characteristic of relocating performing position from upper arm support to straight arm support, and maintaining the continuity motion in a routine, because most movements performed on parallel bars are in forms of straight arm support. If a movement finishes with a position of upper arm support,

the performer must return to straight arm support in order to perform the next movement.

For those movements coded 'EL', the stunt ends with upper arm support, 'ES' is the code for movements performed with straight arm support, and 'EX' coded movements means the exercises with a nature of backward motion or start with a position of upper arm support, which may not follow movements for mount at the end of parallel bars, the 'MX' movement.

A further discussion of analysis movements and full descriptions of the coding symbols is as follows:

1. Movement of Start of Routines.

- a) Type X movements: The type X movements are the movement for mount and they are with a common nature of starting the action at either end of the parallel bars.
- b) Type non-X movements: The type non-X movements are the movements for mount also, they have a nature of starting the action from cross stand between bars or from side stand position.

2. Movement on Finishing of Routines.

The dismount movement naturally falls into this category regardless of whether it finishes with an outer cross stand position or cross stand at the end of the parallel bars. However, all dismounts in this study are completes with outer cross stand

position, because all dismounts mentioned in Code of Points are dismount from the side of parallel bars.⁴

3. Movements Between Mount and Dismount.

- a) **Direction of the Movement:** The direction of movement is classified in forward or backward movement. The backward movement is not suitable to be placed immediately after the type X movement, because it will cause a fall off the parallel bars.
- b) **Supporting Form of Movement:** The supporting form of movement in this study is classified into straight arm support and upper arm support.

4. Degree of Difficulty.

The degree of difficulty of the movements discussed in this study was predetermined by the International Gymnastics Federation (FIG) and published in Code of Points.⁵

B. Description of the Code Used.

- A : Movement with basic forms of an exercise part.
- B : Movement of medium difficulty.
- C : Movement with superior difficulty.

⁴Code of Points, p. 138.

⁵Ibid, pp. 116-141.

- D : Dismount.
- E : Movement between mount and dismount.
- EX : Exercises with a nature of backward movement, and the movements which can not immediately follow 'MX' movements.
- H : Movement from upper arm support position to straight arm support.
- L : Movement ending with upper arm support.
- M : Mount.
- MS : Mount at the end of parallel bars.
- S : Movements performed with straight arm support.

C. Coding of the IBM Card.

An IBM card has 80 columns, columns one to four were used to code the nature of movement, columns five to seventy-nine were used to store the description of movement. The first column was coded to identify the major function of movement, such as mount or dismount. Second column was coded with degree of difficulty. Third column was coded to identify subordinate function of movement, such as arm position during performing movements in forms of straight arm support or upper arm support. Fourth column was coded with type X movement only.

A complete coded movement may have a combined code as EBLX, which means a movement between mount and dismount with

a medium degree of difficulty and not suitable to be placed immediate after MX movement.

D. List of the Complete Coded Movement.

The complete coded movements are shown in TABLE II; they were punched into IBM card, ready for the process of composing routines on parallel bars.

TABLE II

THE COMPLETE LIST OF THE TWENTY-NINE SELECTED MOVEMENTS

EBL SALTO FORWARD TO UPPER ARM SUPPORT,
 EBS REAR VAULT OVER ONE BAR TO CATCH, GLIDE KIP, FRONT VAULT TO LAYBACK,
 EBS CAST TO REARWARD SWING IN SUPPORT,
 EBS FROM FORWARD SWING IN SUPPORT BASKET TO SUPPORT,
 FALX HALF TURN FROM SUPPORT TO UPPER ARM HANG,
 EBS SALTO BACKWARD TO SUPPORT,
 EBSX CZFCHWENDE TO FORWARD SWING,
 EBHX STEMME FORWARD WITH 1/2 TURN, FEET AT LEAST AT RAIL HEIGHT,
 FA X STUTZKEHRE FORWARD TO FORWARD SWING IN SUPPORT, BODY AT LEAST HORIZONTAL,
 EBLX STUTZKEHRE FORWARD TO FORWARD SWING IN UPPER ARM HANG,
 EBS CZECHWENDE TO 'L' SUPPORT,
 EAS HANDSTAND, PRESS WITH BENT BODY AND BENT ARMS,
 EBHX STEMME BACKWARD TO FREE SUPPORT SCALE,
 EBSX HANDSTAND PIVOT BACKWARD,
 ECS CAST TO 'L' SUPPORT,
 EBS HANDSTAND, PRESS WITH STRAIGHT BODY AND BENT ARMS,
 MA FROM CROSS STAND SLIDE KIP TO SUPPORT,
 MA FROM SUTER SIDESTAND FRONTWAYS FRONT VAULT TO FORWARD SWING IN SUPPORT,
 MA X FROM CROSS STAND FRONTWAYS AT END OF BARS, JUMP AND STRADDLE TO L SUPPORT,
 MB FROM CROSS STAND BASKET TO SUPPORT,
 DB SALTO FORWARD TO OUT CROSS STAND.
 DA DOUBLE REAR VAULT BACKWARD DISMOUNT.
 DA SWING FORWARD TO REAR VAULT DISMOUNT WITH 1/2 TURN TO FACE BACKWARD.
 FAHX STEMME FORWARD SUPPORT,
 EAS STEMME BACKWARD TO SUPPORT AND FORWARD SWING TO STRADDLE CUT,
 FAHX UPPER ARM KIP,
 EAS DROP KIP,
 FAHX STEMMEBACK TO SUPPORT,
 EASX ROLL BACKWARD WITH GRASP TO FORWARD SWING,

III. PROGRAMMING THE COMPUTER TO COMPOSE A PROPER ROUTINE ON PARALLEL BARS

A. Programming Procedures.

The computer language AUTOCODER for the IBM 1401 system was chosen to write a program in this study.

First, the computer was commanded to pick up a movement for starting the exercises. If it is a type X movement, that means the movement starts at the end of bars, and can not be followed by EX type movements. If it is just an M movement, there is no restriction on what kind of movements must follow.

The second movement must be an E type--suppose it has a L coded--and the next movement must be a EH type movement, because movements ending up with a position of upper arm support should return to straight arm support before going on to perform any other movement. This routine check will be continually executed by the computer until it comes to the movement before dismount.

The movement before dismount has to be an ES type, because most of the dismounts can not be performed if the previous movement finishes with a position of upper arm support.

The last movement is dismount. It is the eighth movement in the component of this computerized routine.

The above instructions were written in AUTOCODER and

punched into IBM cards. These instructions were carried out by the computer when it composed the routines. A complete program is shown in the appendix.

B. The Run Through Procedures.

Before data were fed into the IBM 1401 system, each complete coded movement was punched into a different IBM card. The original twenty-nine cards were reproduced into 232 cards to facilitate more routines coming out at the first run through.

IV. RESULTS OF THE COMPUTERIZED ROUTINE
ON PARALLEL BARS

After the program cards were fed into the computer, the IBM 1401 system took about four minutes to memorize the instructions, then it ran through 232 data cards with amazing speed, and printed out eleven routines in 45 seconds. Second run-through of the data cards resulted in an outcome of fifteen routines in 38 seconds. Before the second run-through, the data cards were mixed to enable different selection of movements by the computer.

The following 26 computerized routines were the production of coded movements. The elements of these routines have been checked with the requirements of the International Gymnastic Federation (FIG) rules, such as swing, flight, strength simultaneous release of grasp, and static parts. All the computerized routines show a close agreement with these FIG

requirements. Based upon the evidence obtained in this study, it is concluded that (1) The individual gymnastic movement on parallel bars can be coded for computer selection. (2) The IBM 1401 computer system does have the ability to select gymnastic movements to compose routines on parallel bars. (3) The computerized routine is a workable routine.

LIST OF COMPUTERIZED ROUTINES

1. FROM CROSS STAND FRONTWAYS AT END OF BARS, JUMP AND STRADDLE TO L SUPPORT,
CAST TO REARWARD SWING IN SUPPORT,
FROM FORWARD SWING IN SUPPORT BASKET TO SUPPORT,
STEMME BACKWARD TO FREE SUPPORT SCALE,
HANDSTAND PIVOT BACKWARD,
CAST TO 'L' SUPPORT,
SALTO BACKWARD TO SUPPORT,
DOUBLE REAR VAULT BACKWARD DISMOUNT.
2. FROM CROSS STAND BASKET TO SUPPORT,
HANDSTAND, PRESS WITH STRAIGHT BODY AND BENT ARMS,
STUTZKEHRE FORWARD TO FORWARD SWING IN SUPPORT, BODY AT LEAST HORIZONTAL,
STEMME FORWARD WITH 1/2 TURN, FEET AT LEAST AT RAIL HEIGHT,
FROM FORWARD SWING IN SUPPORT BASKET TO SUPPORT,
UPPER ARM KIP,
HANDSTAND PIVOT BACKWARD,
SWING FORWARD TO REAR VAULT DISMOUNT WITH 1/2 TURN TO FACE BACKWARD.
3. FROM CROSS STAND SLIDE KIP TO SUPPORT,
CAST TO REARWARD SWING IN SUPPORT,
HANDSTAND, PRESS WITH STRAIGHT BODY AND BENT ARMS,
SALTO FORWARD TO UPPER ARM SUPPORT,
STEMME FORWARD SUPPORT,
HANDSTAND, PRESS WITH BENT BODY AND BENT ARMS,
DROP KIP,
DOUBLE REAR VAULT BACKWARD DISMOUNT.
4. FROM SUTER SIDESTAND FRONTWAYS FRONT VAULT TO FORWARD SWING IN SUPPORT,
STEMME BACKWARD TO SUPPORT AND FORWARD SWING TO STRADDLE CUT,
DROP KIP,
HALF TURN FROM SUPPORT TO UPPER ARM HAND,
STEMME FORWARD WITH 1/2 TURN, FEET AT LEAST AT RAIL HEIGHT,
DROP KIP,
FROM FORWARD SWING IN SUPPORT BASKET TO SUPPORT,
SWING FORWARD TO REAR VAULT DISMOUNT WITH 1/2 TURN TO FACE BACKWARD.

5. FROM CROSS STAND SLIDE KIP TO SUPPORT,
STEMME BACKWARD TO SUPPORT AND FORWARD SWING TO STRADDLE CUT,
STEMME FORWARD WITH 1/2 TURN, FEET AT LEAST AT RAIL HEIGHT,
STEMME FORWARD SUPPORT,
HANDSTAND PIVOT BACKWARD,
SALTO BACKWARD TO SUPPORT,
CZECHWENDE TO FORWARD SWING,
SWING FORWARD TO REAR VAULT DISMOUNT WITH 1/2 TURN TO FACE BACKWARD.
6. FROM CROSS STAND SLIDE KIP TO SUPPORT,
HALF TURN FROM SUPPORT TO UPPER ARM HANG,
STEMME FORWARD WITH 1/2 TURN, FEET AT LEAST AT RAIL HEIGHT,
HANDSTAND PIVOT BACKWARD,
SALTO BACKWARD TO SUPPORT,
CZECHWENDE TO L SUPPORT,
HANDSTAND PIVOT BACKWARD,
DOUBLE REAR VAULT BACKWARD DISMOUNT.
7. FROM CROSS STAND BASKET TO SUPPORT,
DROP KIP,
HANDSTAND, PRESS WITH STRAIGHT BODY AND BENT ARMS,
STUTZKEHRE FORWARD TO FORWARD SWING IN SUPPORT, BODY AT LEAST HORIZONTAL,
CZECHWENDE TO L SUPPORT,
SALTO FORWARD TO UPPER ARM SUPPORT,
HANDSTAND, PRESS WITH BENT BODY AND BENT ARMS,
SALTO FORWARD TO OUT CROSS STAND.
8. FROM CROSS STAND FRONTWAYS AT END OF BARS, JUMP AND STRADDLE TO L SUPPORT,
CAST TO REARWARD SWING IN SUPPORT,
FROM FORWARD SWING IN SUPPORT BASKET TO SUPPORT,
STEMME BACKWARD TO FREE SUPPORT SCALE,
HANDSTAND PIVOT BACKWARD,
CAST TO 'L' SUPPORT,
SALTO BACKWARD TO SUPPORT,
DOUBLE REAR VAULT BACKWARD DISMOUNT.

9. FROM CROSS STAND BASKET TO SUPPORT,
HANDSTAND, PRESS WITH STRAIGHT BODY AND BENT ARMS,
CZECHWENDE TO L SUPPORT,
SALTO FORWARD TO UPPER ARM SUPPORT,
UPPER ARM KIP,
CZECHWENDE TO FORWARD SWING,
REAR VAULT OVER ONE BAR TO CATCH, GLIDE KIP, FRONT VAULT TO LAYBACK,
DOUBLE REAR VAULT BACKWARD DISMOUNT.

10. FROM SUTER SIDESTAND FRONTWAYS FRONT VAULT TO FORWARD SWING IN SUPPORT,
HANDSTAND PIVOT BACKWARD,
UPPER ARM KIP,
STEMME FORWARD SUPPORT,
STEMME BACKWARD TO FREE SUPPORT SCALE,
STEMME FORWARD SUPPORT,
FROM FORWARD SWING IN SUPPORT BASKET TO SUPPORT,
DOUBLE REAR VAULT BACKWARD DISMOUNT.

11. FROM CROSS STAND SLIDE KIP TO SUPPORT,
HALF TURN FROM SUPPORT TO UPPER ARM HANG,
STEMME FORWARD WITH 1/2 TURN, FEET AT LEAST AT RAIL HEIGHT,
FROM FORWARD SWING IN SUPPORT BASKET TO SUPPORT,
UPPER ARM KIP,
HANDSTAND PIVOT BACKWARD,
SALTO BACKWARD TO SUPPORT,
SWING FORWARD TO REAR VAULT DISMOUNT WITH 1/2 TURN TO FACE BACKWARD.

12. FROM CROSS STAND SLIDE KIP TO SUPPORT,
CAST TO REARWARD SWING IN SUPPORT,
HANDSTAND, PRESS WITH STRAIGHT BODY AND BENT ARMS,
SALTO FORWARD TO UPPER ARM SUPPORT,
STEMME FORWARD WITH 1/2 TURN, FEET AT LEAST AT RAIL HEIGHT,
HANDSTAND PIVOT BACKWARD,
DROP KIP,
DOUBLE REAR VAULT BACKWARD DISMOUNT.

13. FROM CROSS STAND BASKET TO SUPPORT,
STEMME FORWARD SUPPORT,
STUTZKEHRE FORWARD TO FORWARD SWING IN UPPER ARM HANG,
UPPER ARM KIP,
CAST TO REARWARD SWING IN SUPPORT,
HANDSTAND PIVOT BACKWARD,
HANDSTAND, PRESS WITH STRAIGHT BODY AND BENT ARMS,
DOUBLE REAR VAULT BACKWARD DISMOUNT.
14. FROM CROSS STAND SLIDE KIP TO SUPPORT,
HALF TURN FROM SUPPORT TO UPPER ARM HANG,
STEMME FORWARD WITH 1/2 TURN, FEET AT LEAST AT RAIL HEIGHT,
STEMME BACKWARD TO SUPPORT AND FORWARD SWING TO STRADDLE CUT,
DROP KIP,
HALF TURN FROM SUPPORT TO UPPER ARM HANG,
DROP KIP,
SALTO FORWARD TO OUT CROSS STAND.
15. FROM SUTER SIDESTAND FRONTWAYS FRONT VAULT TO FORWARD SWING IN SUPPORT,
CZECHWENDE TO L SUPPORT,
SALTO FORWARD TO UPPER ARM SUPPORT,
STEMME FORWARD SUPPORT,
CZECHWENDE TO FORWARD SWING,
STEMME BACKWARD TO SUPPORT AND FORWARD SWING TO STRADDLE CUT,
SALTO BACKWARD TO SUPPORT,
SALTO FORWARD TO OUT CROSS STAND.
16. FROM CROSS STAND FRONTWAYS AT END OF BARS, JUMP AND STRADDLE TO L SUPPORT,
CAST TO REARWARD SWING IN SUPPORT,
CZECHWENDE TO FORWARD SWING,
HALF TURN FROM SUPPORT TO UPPER ARM HANG,
STEMME BACKWARD TO FREE SUPPORT SCALE,
HANDSTAND PIVOT BACKWARD,
CAST TO 'L' SUPPORT,
DOUBLE REAR VAULT BACKWARD DISMOUNT.

17. FROM CROSS STAND BASKET TO SUPPORT,
HANDSTAND, PRESS WITH STRAIGHT BODY AND BENT ARMS,
CZECHEWENDE TO L SUPPORT,
SALTO FORWARD TO UPPER ARM SUPPORT,
UPPER ARM KIP,
STEMMEBACK TO SUPPORT,
STEMMEBACKWARD TO SUPPORT AND FORWARD SWING TO STRADDLE CUT,
DOUBLE REAR VAULT BACKWARD DISMOUNT.
18. FROM CROSS STAND BASKET TO SUPPORT,
SALTO FORWARD TO UPPER ARM SUPPORT,
STEMME FORWARD WITH 1/2 TURN, FEET AT LEAST AT RAIL HEIGHT,
HANDSTAND, PRESS WITH BENT BODY AND BENT ARMS,
STUTZKEHRE FORWARD TO FORWARD SWING IN UPPER ARM HANG,
UPPER ARM KIP,
FROM FORWARD SWING IN SUPPORT BASKET TO SUPPORT,
DOUBLE REAR VAULT BACKWARD DISMOUNT.
19. FROM CROSS STAND SLIDE KIP TO SUPPORT,
CAST TO REARWARD SWING IN SUPPORT,
HANDSTAND, PRESS WITH STRAIGHT BODY AND BENT ARMS,
SALTO FORWARD TO UPPER ARM SUPPORT,
STEMME FORWARD SUPPORT,
STEMME FORWARD WITH 1/2 TURN, FEET AT LEAST AT RAIL HEIGHT,
HANDSTAND, PRESS WITH BENT BODY AND BENT ARMS,
DOUBLE REAR VAULT BACKWARD DISMOUNT.
20. FROM SUTER SIDESTAND FRONTWAYS FRONT VAULT TO FORWARD SWING IN SUPPORT,
REAR VAULT OVER ONE BAR TO CATCH, GLIDE KIP, FRONT VAULT TO LAYBACK,
STUTZKEHRE FORWARD TO FORWARD SWING IN UPPER ARM HANG,
STEMME FORWARD SUPPORT,
STUTZKEHRE FORWARD TO FORWARD SWING IN UPPER ARM HANG,
CZECHEWENDE TO L SUPPORT,
SALTO FORWARD TO OUT CROSS STAND.

21. FROM SUTER SIDESTAND FRONTWAYS FRONT VAULT TO FORWARD SWING IN SUPPORT,
CZECHEWENDE TO L SUPPORT,
SALTO FORWARD TO UPPER ARM SUPPORT,
STEMME FORWARD SUPPORT,
CZECHEWENDE TO FORWARD SWING,
STEMMEBACKWARD TO SUPPORT AND FORWARD SWING TO STRADDLE CUT,
CAST TO REARWARD SWING IN SUPPORT,
DOUBLE REAR VAULT BACKWARD DISMOUNT.
22. FROM CROSS STAND SLIDE KIP TO SUPPORT,
HALF TURN FROM SUPPORT TO UPPER ARM HANG,
STEMME FORWARD SUPPORT,
SALTO BACKWARD TO SUPPORT,
HANDSTAND, PRESS WITH BENT BODY AND BENT ARMS,
CAST TO 'L' SUPPORT,
CAST TO REARWARD SWING IN SUPPORT,
DOUBLE REAR VAULT BACKWARD DISMOUNT.
23. FROM SUTER SIDESTAND FRONTWAYS FRONT VAULT TO FORWARD SWING IN SUPPORT,
STEMMEBACKWARD TO SUPPORT AND FORWARD SWING TO STRADDLE CUT,
DROP KIP,
UPPER ARM KIP,
STEMME FORWARD SUPPORT,
FROM FORWARD SWING IN SUPPORT BASKET TO SUPPORT,
HANDSTAND PIVOT BACKWARD,
DOUBLE REAR VAULT BACKWARD DISMOUNT.
24. FROM CROSS STAND BASKET TO SUPPORT,
STEMME BACKWARD TO FREE SUPPORT SCALE,
HALF TURN FROM SUPPORT TO UPPER ARM HANG,
STEMME FORWARD WITH 1/2 TURN, FEET AT LEAST AT RAIL HEIGHT,
CAST TO 'L' SUPPORT,
STEMMEBACK TO SUPPORT,
SALTO BACKWARD TO SUPPORT,
DOUBLE REAR VAULT BACKWARD DISMOUNT.

25. FROM CROSS STAND BASKET TO SUPPORT,
HANDSTAND, PRESS WITH STRAIGHT BODY AND BENT ARMS,
CZECHEWENDE TO L SUPPORT,
SALTO FORWARD TO UPPER ARM SUPPORT,
STEMME FORWARD WITH 1/2 TURN, FEET AT LEAST AT RAIL HEIGHT,
FROM FORWARD SWING IN SUPPORT BASKET TO SUPPORT,
HANDSTAND PIVOT BACKWARD,
DOUBLE REAR VAULT BACKWARD DISMOUNT.
26. FROM CROSS STAND SLIDE KIP TO SUPPORT,
STEMME BACKWARD TO SUPPORT AND FORWARD SWING TO STRADDLE CUT,
STEMME FORWARD WITH 1/2 TURN, FEET AT LEAST AT RAIL HEIGHT,
STEMME FORWARD SUPPORT,
HANDSTAND PIVOT BACKWARD,
SALTO BACKWARD TO SUPPORT,
CZECHEWENDE TO FORWARD SWING,
SWING FORWARD TO REAR VAULT DISMOUNT WITH 1/2 TURN TO FACE BACKWARD.

CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

I. SUMMARY

The purpose of this study was to investigate the feasibility of programming a computer to compose various gymnastic movements into a proper routine on the parallel bars.

Twenty-nine different movements from Code of Points of the International Gymnastic Federation and Manual of Badge Examination from Hong Kong Amateur Gymnastic Association were used. The movements were coded and punched into IBM cards. A program written in AUTOCODER was employed in this study. The IBM 1401 system took only 83 seconds to print out 26 workable routines on parallel bars.

A review of background literature revealed the application of computers mainly in business, industry, and sciences. The educational application of computers is mostly in administrative functions such as routine record-keeping and accounting. The Computer-Assisted-Instruction (CAI) is a potentially powerful instructional tool in the nation's classroom; however, it is still in the experimental stage.

II. FINDINGS

Within the limits of this study, the findings include

three areas:

1. The individual gymnastic movement on parallel bars can be coded for computer selection.
2. The IBM 1401 computer system does have the ability to select gymnastic movements to compose routines on parallel bars.
3. The computerized routines on parallel bars are workable routines.

III. CONCLUSIONS

It is concluded that, within the limitations of this study, the scientific selection of gymnastic movements to compose routines by computer is possible. It is a first step toward more complicated possibilities of utilizing the computer in the field of sports and physical education.

With a developed program for the IBM 1401 system and the availability of a computer on campus, the time and energy used on composing routines on parallel bars can be saved.

IV. RECOMMENDATIONS

1. Further investigation is needed concerning the use of computers in a wider range of possible selections in various activities.
2. Develop computerized routines on other pieces of

apparatus.

3. Develop computerized gymnastic routines with graphic illustrations.

4. Programming a computer to compose routines based on point values.

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D. NEWSPAPER

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APPENDIX

AUTOCODER PROGRAM FOR
COMPOSING GYMNASTIC MOVEMENTS
ON PARALLEL BARS

AUTOCODER

SEQ	LABEL	OPCD	OPERAND	
0001		JOB	THESIS	CHUNG KIT YU
0002		CTL	411	
0003	CARD	DA	1x80,G	
0004	CODE		1,1	
0005	SOMP		3,3	
0006	COMP		4,4	
0007	DESCR		5,79	
0008	ATEND		80,80	
0009	CHECK	DCW	#1	
0010	STORE	DA	1x72,G	
0011	BEGIN	MLC	'00',COUNT	
0012	START1	S	'1',COUNT	
0013	START	R		
0014		MLCWA	CARD+80,081	
0015		MRCM	001,CARD	
0016		C	ATEND,'X'	
0017		BE	END	
0018		A	'1',COUNT#2	
0019		MZ	' ',COUNT	
0020		C	COUNT,'01'	
0021		BE	CARD1	
0022		C	COUNT,'02'	
0023		BE	CARD2	
0024		C	COUNT,'07'	
0025		BH	CARD3	
0026		BE	CARD7	
0027		C	COUNT,'08'	
0028		BU	BEGIN	
0029		B	CARD8	
0030	CARD1	C	CODE,'M'	
0031		BU	START1	
0032		MLC	COMP,CHECK	
0033		B	WRITE	
0034	CARD2	C	CODE,'E'	
0035		BU	START1	
0036		MLC	SOMP,HOLDL#1	
0037		BCE	CARDEX,COMP,X	
0038		B	WRITE	
0039	CARDEX	C	COMP,CHECK	
0040		BU	WRITE	
0041		B	START1	
0042	CARD3	BCE	CARD3A,CODE,E	
0043		B	START1	

SEQ	LABEL	OPCD	OPERAND
0044	CARD3A	BCE	CARDEL,HOLDL,L
0045		B	WRITE
0046	CARDEL	BCE	WRITE,SOMP,H
0047		B	START1
0048	CARD7	C	CODE,'F'
0049		BU	START1
0050		C	SOMP,'S'
0051		BE	WRITE
0052		B	START1
0053	CARD8	BCE	WRTLST,CODE,D
0054		B	START1
0055	OK	CS	332
0056		CS	
0057		MLC	STORE,290
0058		W	
0059		MLC	'00',COUNT
0060		B	CARD8
0061		MLC	DESCR,STORE
0062		A	'1',CK#1
0063		B	START
0064	WRITE	CS	332
0065		CS	
0066		C	DESCR,DFSCR1#75
0067		BE	START1
0068		MLC	DESCR,DESCR1
0069		MLC	DESCR,290
0070		W	
0071		MLC	SOMP,HOLDL
0072	RETURN	C	CK,'1'
0073		BE	EXROUT
0074		B	START
0075	EXROUT	CS	299
0076		MLC	STORE,290
0077		W	
0078		MLC	'0',CK
0079		B	START
0080	WRTLST	CS	332
0081		CS	
0082		MLC	DESCR,290
0083		W	
0084		CC	J
0085		MLC	'00',COUNT
0086		B	RETURN
0087	END	H	END
0088		NOP	
0089		END	START