COMPUTER AIDED DESIGN OF A CAM MECHANISM'S SYSTEM

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A PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A POSTGRADUATE DIPLOMA IN COMPUTER SCIENCE TO THE DEPARTMENT OF MATHEMATICS/COMPUTER SCIENCE, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE, NIGERIA.

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CERTIFICATION

This is to certify that this project work is carried out by **SULE IBRAHIM O. (PGD/MCS/1999/2000/929)** in the department of Mathematics/Computer Sciences, School of Science and Science Education, Federal University of Technology, Minna, Niger State, Nigeria.

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-------------------------------------- SIGNATURE AND DATE

DEDICATION

This project is dedicated to Almighty Allah for the infinity blessing and mercy over me and to my father, Mallam Aliyu Suleman and my mother Mrs. Halimat O. Suleman for their caring.

ACKNOWLEDGEMENT

My sincerely gratitude goes to Almighty Allah for guidance and protection given to me through the course of my studies.

This special gratitude will extend to my Supervisor, Mr. Isah Audu for his patience, academic guidance and support during the course of my project. May Allah (S.A.W.) continue to shower his blessings on him in multitude. My heart felt gratitude to the HOD Mathematics and Computer Department and the entire staff members for their unflinching support through out the course of the program. More grease to their elbow.

I am equally grateful to my dear parent Mr. and Mrs. A.O. Suleiman for their care, moral and financial support that have brought me to this stage of my education career. My appreciation also goes to my humble wife Mrs. Rukayat Suleman and my bouncing daughter Nimatullahi for their understanding and caring.

I will also appreciate the advice from members of my family, relative friends both in Nigeria and abroad. They include Ah. S. I. Bello, Mr. Abdulrazak Bello, Mr. Abdulkareem, Mr. Isah, Mr. Gambari, Mr. Kazeem, Mr. Akinyemi, Mallam Hussein, Mr. Yahaya, Mr. Mazamiyu, Mr. Usman, Mr. Kamaludeen, Mr. Habibu, Mr. Hassan, Mr. Tijani, Mrs. Maku, Mr. Abu, Mr. Shaibu and others. May Almighty Allah continue to guide them alright. Amen.

ABSTRACT

The system of designing with or without adequate data, and also result in taking longer time to achieve desirable result. This lead to Computer Aided Design CAD system, with a faster operational features which demonstrate computer capability in design, simulation and graphical design of different types of engineering works. It produces accurate, reliable and timely information for decision taking.

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CHAPTER ONE

INTRODUCTION

1.1 OVERVIEW OF COMPUTER-AIDED DESIGN/COMPUTER AIDED MANUFACTURE OR CAD/CAM.

The process by which computers are employed to enhance the manufacture and development of products. Products may be produced more quickly, more accurately, or with reduced cost, by the appropriate application of computer technology.

Computer Aided Design (CAD) may be defined as the utilization of a computer base system to aid the development of a design from the initial concepts through to the detailed description, from which it may be manufactured. The task which must be tackled may cover initial visualization, design analysis teething and development and the subsequent provision of design specification.

In addition, it is reasonable to expect the CAD system to be capable of utilizing and maintaining a design data-base containing details of existing design which can be used as a basis for future design work.

Computer Aided Design (CAD) system may be used to model many, if not all, of the features of a particular product.

Typically, these would be the size, shape, and form of each component part, stored as two-dimensional and three-dimensional drawings. Once this dimensional data has been entered and stored in the computer system, the designer is able to manipulate or modify design ideas with great ease as the product development is pursued. Moreover, the combined ideas of many designers are shared and integrated as data is moved rapidly across computer networks, enabling designers and engineers located in different global location to work together as a team. CAD system is also able to stimulate the performance of a product. They can test whether a proposed electronic circuit will work as intended, whether a bridge will carry predicted load safely, and even whether tomato ketchup will pour correctly from a newly designed container.

Computer Aided Manufacture (CAM) is less straight forward since it is accepted practice to apply the term to application ranging from straight forward machine tools control system to fully automated large scale manufacturing system. In this instance, the activities grouped together under the heading of CAM encompass computer Aided part programming (CAPP) and Component Inspection, as well as Computer Aided Processes Planning, Plant layout, and production planning and scheduling.

When CAD systems are linked to manufacturing equipment which is also controlled by computer, they form an integrated CAD/CAM (Computer-Aided Manufacture) system. CAM offers significant advantages over more traditional approaches by controlling manufacturing equipment with computer instead of human operators. CAM equipment is usually associated with the elimination of operator error and the reduction of labour cost. However, the consistent accuracy and predicted optimum use of equipment lead to even more significant advantages. For example, cutting blades and tools will wear more slowly and break less frequently, reducing manufacturing cost still further. Against these saving should be set the higher costs of capital equipment or the possible social implication of maintaining productivity with a reduced work force. CAM equipment relies on a series of numeric codes, stored in computer file, to control manufacturing operation. This Computer Numeric Control (CNC) is provided by describing machine operations in terms of the special codes and component shape geometry, and building specialized computer file or "part program". The development of these part programs is a specialized computer software usually form the link between CAD and CAM systems.

Computer Integrated Manufacturing may therefore be seen as being the result of a fully Integrated CADCAM system. Indeed an accepted definition of CIM suggests that it covers almost every department of a Manufacturing organization. Implicit within this definition is a degree of integration between the various sub-systems existing within the organization as a whole.

The level of integration achieved within any organization will depend upon the system adopted to satisfy their design and manufacturing needs.

1.2 FEASIBILITY OF DESIGN.

The features of CAD system are exploited by designer, engineers, and manufacturers to suit the particular needs of their own situation. For example, a designer may use the system to produce an early prototype quickly and test the feasibility of product, whilst a manufacturer may choose to use the system because it is the only way an intricate component can be accurately produced. The range of features available to CAD/CAM users is continually expanding. Clothing manufacturers may design a garment pattern on a CAD system which automatically positioned on the cloth so that waste material is minimized when a CNC saw or lesser cuts it out.

In addition to CAD information, which describes the shape of an engineering component, the most appropriate material for the manufacture may be selected from the computer database and a range of CNC machines used in combination to produce it. Computer Integrated Manufacture (CIM) exploits the full potential of this technology by combing a wide range of computer aided activities, possibility including stock control of every production process. This provides greater manufacturing flexibility, allowing a company to respond more quickly to the demands of the market place and new product development.

Future developments will include the further integration of "virtual reality" system which enable designers to interact with their virtual prototype products by computer, install building expensive mock-ups to test feasibility.

The area of "rapid prototyping" is also a further development of CAD./CAM techniques, where three-dimensional computer images may be converted into real models by specialized manufacturing equipment, such as a street lithography system.

Hence the purpose of the feasibility design is to investigate the project insufficient depth to be able to provide information which either justifies the development of the new system.

1.2 AIM AND OBJECTIVES OF THE DESIGN

Is to design a system that will aid engineers in producing Cam engineering component faster–reliable, efficiently, accurately and minimize time consumption.

The main objectives involved in the design are as follows:

(i) To demonstrate computer capability in design, simulation and carrying out large volumes of various and different types of engineering work.

(ii) To improve manufacturing and industrial methods by effective implementation of advanced technology.

(iii) To produce accurate, reliable and timely information.

(iv) To produce a system with faster operational features.

(v) To develop a computer base system for designing and manufacturing with aid of numerical control machine.

1.3 METHODOLOGY OF THE DESIGN

There are several methods of gathering in information, they include observations, record, researching, questionnaire and interview. The analysis approach to the investigation will influence the use of various methods.

Selection process should be simplified the exact method of selection which will depend upon many factors.

System must be selected with full consideration of their future integration. CAD system which allowed them to develop their design work, and proved to be extremely successful in the rationalization of existing designs and in the production of new designs.

The introduction of CAD was expanded. Other aspects of Advance Manufacturing Technology (AMT). Care was taken to ensure that CAD was implemented as part of concerted AMT program, under the guidance of Computer Aided Engineering.

The project is centered on the use of computer in designing CAM mechanism system.

The aspect cover by the researcher is limited to designing CAM mechanism, which involves some stages:

(i) Preliminary Information: This involves obtaining of information about the Cam itself what is the function? How can it be achieved?

Cam is a special profile which impact reciprocating or rotating movement on another body called follower.

To achieve the desired movement needed to be impacted to another body, we study the type of various motion required which will be used to draw the displacement diagram in turn draw the Cam profile.

(ii) Displacement diagram: Is achieved from the type of motion provided, to be transmitted to the follower.

(iii) Cam profile: The shape of Cam profile is determined from the displacement graph which shows the maximum lift minimum radius of the Cam.

(iv) Follower Motion: In the design and construction of Cams, a displacement diagram or Cam graph is used, this shows the displacement or lift of the Cam follower plotted against the angular displacement of the Cam. The Cam usually rotates at constant speed so that equal amount of angular displacement occurs in equal intervals of time. The follower, however, is required to start and finish its stroke at rest, thereby having variable velocity. Further, it often remains at rest during some part of the cam rotation. This is known as a period of dwell.

(v) Automation generation: Computerization, of all the data required, design a system sub-code program that will accept the data as input processes these input data and generate an output of displacement diagram graph and Cam file.

1.5 SCOPE AND LIMITATION.

This project is centered on the use of computer in the designing Cam mechanism system which are commonly used in engineering in transmitting motions other than the original motion.

The aspect covers by the researcher is limited to plotting of the graft and Cam profile itself, which involves the following stages:

(i) Type of motion: Obtain information about the type of motion involves at each stages the sample harmonic uniform velocity, uniform acceleration/retardation, and dwell.

(ii) Angular displacement: At a various stroke, having variable velocity the Cam rotate usually at constant speed so that equal amounts of angular displacement occur in equal interval of time.

(iii) Maximum displacement: The max light and minimum level has to be given so that the displacement the angle will work toward the required target.

(iv) Least radius of the Cam: This is the radius where all strokes start and the action of the motion.

CHAPTER TWO

OVERVIEW OF CAD DEVELOPMENT

2.1 DEVELOPMENT OF CAD SYSTEM.

Successful development and implementation should begin with establishment of a CAE management team. The team structure should be possible to develop a planned implementation which considered the needs of each department as a part of a wider plan mapping out the role of CAD within the manufacturing firm.

Careful planning is needed to ensure that the system is integrated into Company in a well controlled and ultimately successful manner. This will depend upon the gradual introduction of the system to the users, with key staff trained to provide areas of know how within each department from which knowledge may be distributed. Also vital, is a well planned work limited to allow the system methodology to develop as both a system and user's develop.

The user's goes on to identify that it is the manipulation of existing designs and standard parts that will offer most saving in both time and money. This feeling is re-enforced else where with a derived parameteric approach to design. These cases would seem to indicate that the true direction for future system development should be in the provision of more powerful design manipulation tools and data base management system for basically two dimensional systems.

Both of the above view points of future development may be justified. Added to them may be the development of system, which truly aid the manufacturing operation within a company. This will include the development of CAD to CAM links able to organize and control the manufacturing facilities of interest in the development with CAD system of manufacturing database capable of indicating available facilities allowing ultimately, optimized design for manufacture.

A further section of industry would regard the development of CAM as being of paramount importance. There is an identifiable need for the provision of "graphical" CAM system allowing user's to generate associated manufacturing information from graphical input intended to facilitate the machining of a desired component such a system would have built the machine tools to be used for a particular set of operations and would result in better design for manufacture.

A comparison was made between a CAD generated and a manually derived past programme. As a consequence of this work an operator was required to enter into a machine tool a simple bounding including automatically generated fillets which had been drawn using a CAD system. This proved to be difficult since the operator needed to specify the start and print of all one including the fillets, which were not dimensioned. Although this was relatively simple to rectify it illustrated that when a designer uses CAD system he should be aware of the information needed for consequent manufacturing operation.

The above consideration of CAD CAM system attributed justify a statement made to the effect that CAD CAM development which may have originated at different ends of the spectrum have gradually approached each other, this may be modified to some degree of overlapping.

2.2 CAD CAM SYSTEM CLASSIFICATION

When embarking upon a CADCAM system selection and implementation process the prospective user should very quickly decide what the major attributes of the required system are, and attempt to match these to the available system.

There are various ways in which we actually write CAD CAM: CAD CAM, CAD-CAM, CAP/CAM and CADCAM are widely used and accepted alternatives, each normally used to indicate a system.

CAD/CAM - two distinct and separate functions each aided by use of computerized system.

CADCAM – two separate function aided by the utilization of computer "linked" by conventional means, i.e. drawings, tape, etc.

CAD – CAM, two self contained system, each complete, joined via formal, perhaps fully computerized links. Such systems are able to communicate, with each other to allow the down loading of paths and associated machine tool instruction.

CADCAM, - a fully integrated system, design manufacturing function shows a common data base which facilitates the information flow around the system as a whole.

CADCAM system have been reviewed and classified in order to facilitate the matching of user need to available attributes. This is based upon a classification system which considers the level of each system in terms of its design functions, database facilities, manufacturing output (geometry and tool path outputs), design analysis capacity production engineering data link, (Bill of materials and production control), and general drafting facilities.

Although at an early stage this analysis has indicated the system may be divided into the following groups:

(i) Basic Drafting System – capable of a high level of drafting and design, but limited in their eventual output normally intended to produce drawing.

(ii) Basic Design system – extension of the above system which are more open and hence allow the utilization of database parametric parts manipulation bill material and some design analysis packages.

(iii) Three Dimension Drafting system: - representing the ultimate in "drawing machine" able to produce solid or surface models for use in design visualization.

(iv) Three Dimension system: - extension of the above with the added power of design analysis capabilities and high level of outputs into databases.

(v) CAM graphics system: - Basically enhanced part programming system allowing the graphical definition of components and associated tool paths.

(vi) Basic CADCAM system: - capable of design and manufacturing milled and turned component generating machine tool instruction and interfacing with other manufacturing function via a manufacturing database, may be capable of drafting.

(vii) Three Dimension CADCAM system: - advanced system allowing the creation of three dimension solid and/or surface model and associated manufacturing information usually operate via a database which provides a link with other designs and manufacturing functions.

The above classification is of limited use at present. They represent an early attempt at producing a methodology by which the needs of a prospective user can be quickly matched to available system. They do show however the range of sophistication currently available.

The selection and implementation of a CADCAM system will depend upon a wide range of factors, each of which must be considered as part of an overall planned more into computer aided engineering. Factors highlighted have explored possible methods of matching required facilities to available systems.

In attempting to define the meaning of CADCAM, the work has indicated that there is a diverse range of systems available. If a successful implementation is to be achieved selection of a suitable system is vital as is well planned and managed implementation and utilization strategy. This must be seen as an open-ended process, which is capable of managing the system to meet present and future demands.

2.3 CAM MECHANISMS

A Cam mechanism is a body with a special profile, which supports reciprocating or oscillating movement to another body called the follower.

Many mechanical operations require motion other than that supplied. For instance, circular or rotating motion provided by an electric motor may be converted into reciprocating or straight-line motion by some means, in a number of machine tools.

The tailstock of a letter machine converts the rotational motion of hand wheel into strait-line motion of the lathe barrel by a screw thread (through a helix). Such a conversion also take place in head-screw and cross slide of machine tools, in measuring instrument (for example the barrel of a micrometer), and providing the force in a fly-press, screw jack, or vice.

With petrol and steam engine, reciprocal or straight-line motion is converted into rotational motion by means of a crank with steam engines and locomotives, a cross head is used to convert the type of motion.

Also in a video machine, the motor rubber screw, the spur gear housing a Cam slot design which in turn operate the intake and ejection of video cassette, this process is been electro-mechanically designed.

Conversely, straight-line motion is obtained rotational motion in machine hacksaw and shaping and slotting machine. Another method of obtaining straight-line motion from rotational motion is through a rack and pinon, such as that used in planning machine table, the saddle of a lathe, or a measuring instrument such as the dial gauge indicator.

An eccentric in a way of producing a non-reversible system of converting from rotational motions to straight-line motion. An eccentric is used to drive small lubrication pumps, to number counter on machinery with continuous operation, and also a means of converting the type of motion on power press.

2.4 CLASSIFICATION OF CAM MECHANISM

Cam mechanism is classified according to their angle of transmission of motion with the follower axis.

(i) Right angle Cam axis: - with this type of cams the follower oscillates or reciprocates in a plane at right angle to the Cam axis and the working edge of the Cam. E.g. Radial, Edge, plate, Disc Cam.

(ii) Parallel Cam axis: - The follower oscillates or reciprocates in plane parallel to the Cam axis. E.g. Cylindrical Cam.

2.5 CAM FOLLOWER

Cam follower may be required to have oscillating or reciprocating motion and this requirement, together with the shape of the Cam, will determine the type of follower used.

(a) Knife, Wedge or Point Follower: - These types of followers are not commonly used, because the rate of wear at the contact point is considerable, but they can be used with Cams of any shape.

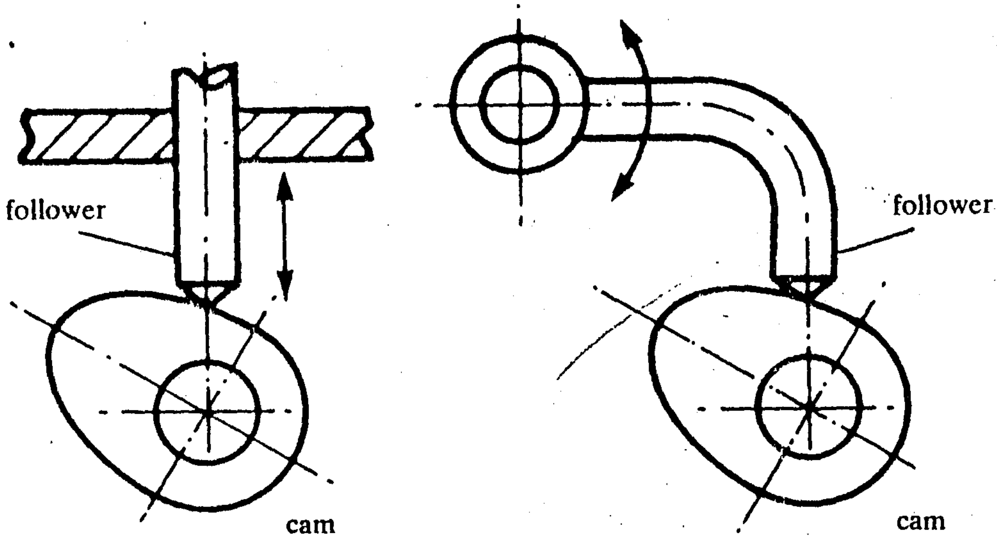
(b) Roller Follower:- Wear at the contact point is almost eliminated with this type of follower as there is little sliding between the contact surfaces. The radius of the roller must be smaller than the least radius on the Cam profile.

(c) Flat or Mushroom Follower:- With Knife and roller followers there is a considerable side thrust between follower and guide, However, side thrust on the guide of a flat follower and guide solely to sliding friction between the contact surface of the Cam follower.

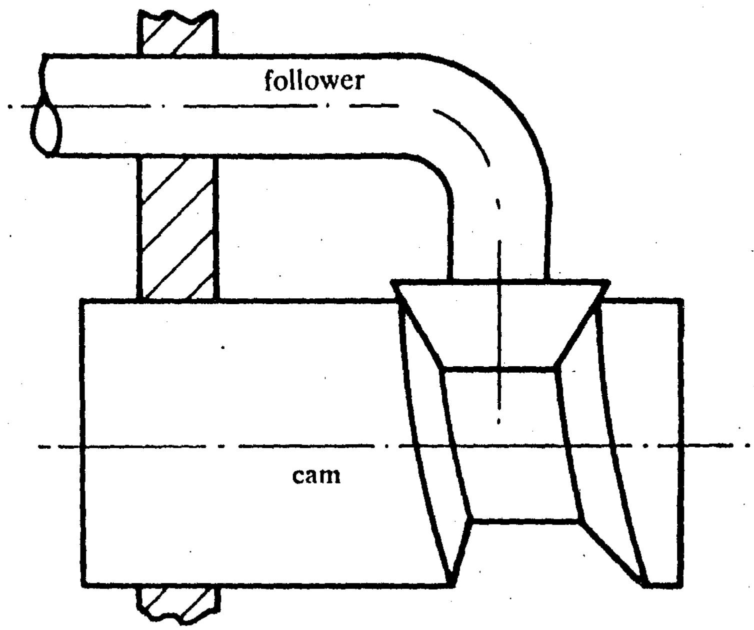
Wear and side thrust on the follower can be reduced if the axis of the follower is offset. As the Cam rotates friction causes the follower to rotate on its own axis.

When using a flat follower, the working edge (or profile) of the Cam must be entirely convex.

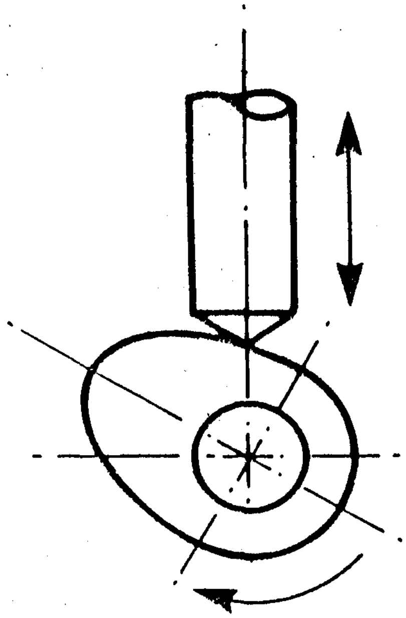
The contact between the Cam and its follower, is positive only on the outstroke, and spring must be fitted to keep both in contact for the remainder of the Cam rotation.



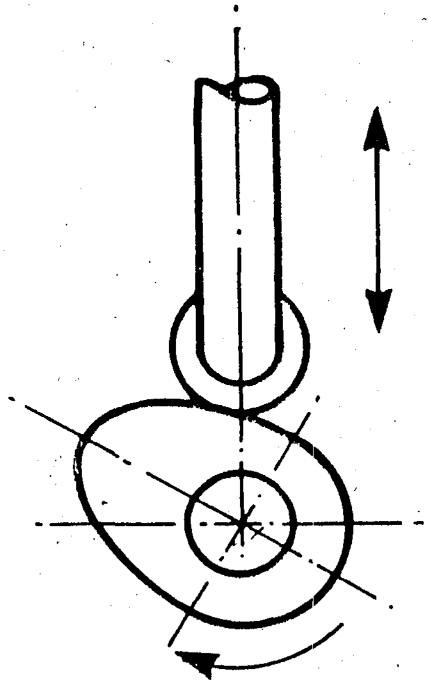
Radial cam



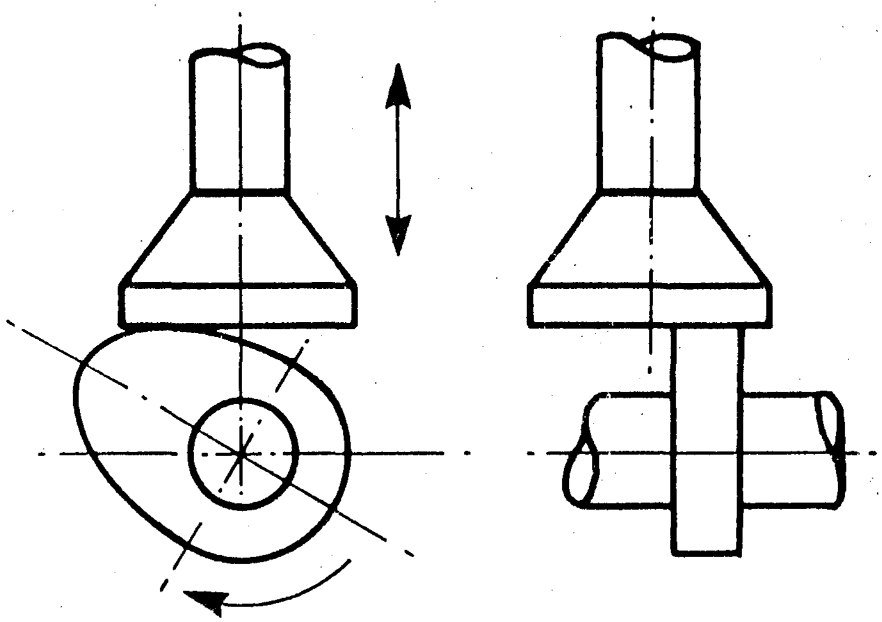
Cylindrical cam



Knife, wedge or point follower



Roller follower



Flat (or mushroom) follower

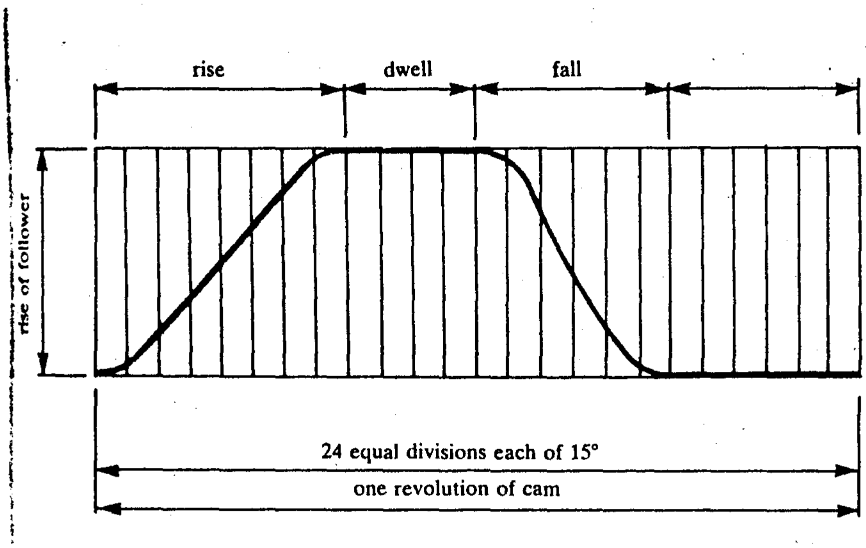
2.6 FOLLOWER MOTION

In the design and construction of Cam, a displacement diagram or a Cam graph is used. This shows the displacement or lift of the Cam follower plotted against the graph is plotted for one complete revolution of the Cam (Fig. 1).

The Cam usually rotate at constant speed so that equal amounts of angular displacement occur in equal interval of time.

The follower, however, is required to start and finish it stroke at rest, thereby having variable velocity. Further, it is often remains at rest during some part of the Cam rotation. This is known as a period of dwell.

Fig. 1. Typical displacement diagram.



Typical displacement diagram

DISPLACEMENT DIAGRAM

The shape of the Cam is determined using displacement diagram of the following. Since Cam provide the simplest means of achieving almost any desired follower motion they present very important mechanism, which are frequently occurring element in many types of machines.

The selection of the type of motion to be used for the follower in transient region depends on the speed of the Cam the noise, the vibration permissible and life expectancy.

2.7 TYPES OF MOTION

(i) Uniform motion:- If the follower is to be uniform velocity it must have equal amount of lift for equal amount of angular displacement, the slope of the curve on the displacement diagram is constant, that is a straight line.

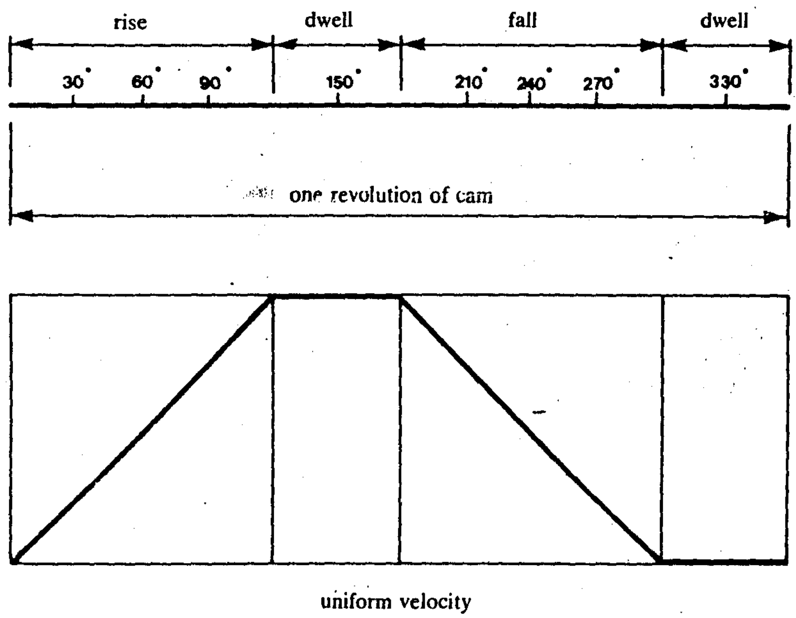
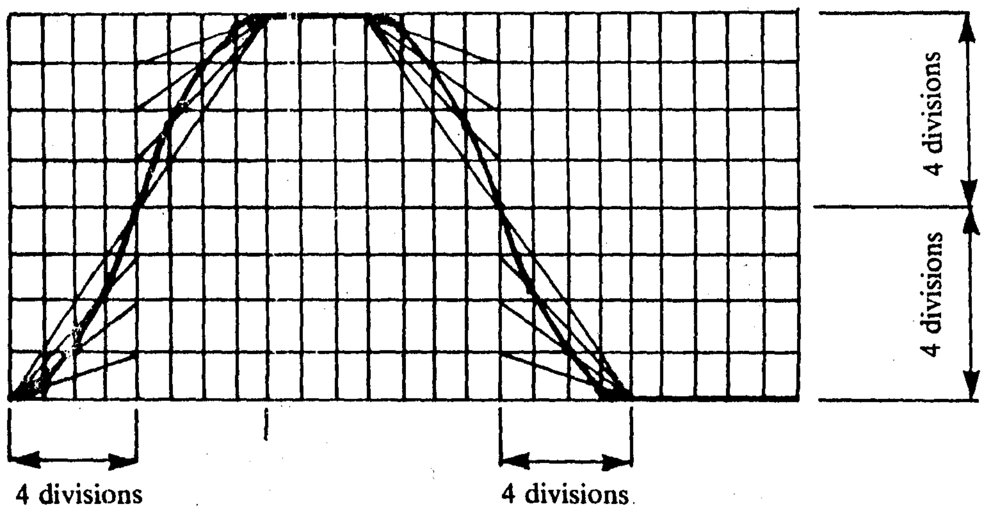
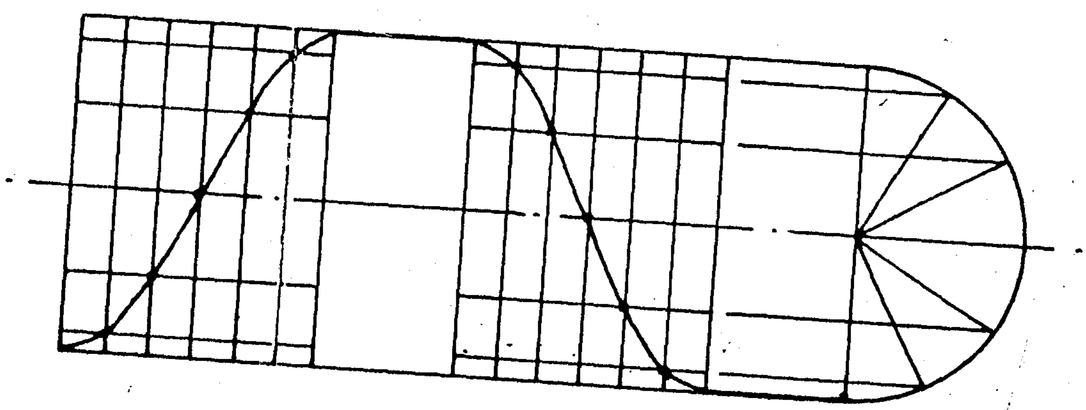


Fig.2 Uniform Velocity.

(ii) Uniform and equal acceleration and retardation:- The curve for the type of motion is of parabolic form. The follower accelerates for the first part of the motion and retard during the second part. This lift of the follower and the angular displacement are divided into the same number of equal part.



(iii) Simple Harmonic motion:- When the follower has simple harmonic motion the displacement diagram or Cam graph is a sine curve whose construction is similar to that of the helix.



CHAPTER THREE

OVERVIEW TO CAD CAM INTEGRATION

3.1 CAD CAM INTEGRATION

CAD CAM INTEGRATION

Computer Integrated Manufacturing may be seen as being the result of a fully integrated CADCAM system. The level of integration achieved within any organization will depend upon the system adopted to satisfy their design and manufacturing needs. Often so called "island of automation" will result with poorly defined communication links. In other cases a more integrated system will result, perhaps, based upon a manufacturing database.

In most cases it appears that the final degree of integration will fall some way short of that anticipated. This is due to various factors. Computer integrated majufacturing, with a stand alone systems linked together by the development of data exchange facilities to form a fully integrated facility. How the integration is achieved depends upon many factors including the organization of the company. Its product range, the design, and manufacturing facilities and processes available and most often, the initial section of the composite systems.

There can be no universal methodology for the selection of CADCAM systems. The selection process adopted will depend upon the circumstances and manufacturing environment of the company. A general outline of a selection process, depicting the important stages which would usually be included in successful implementation. The major limitation of such a selection approach lies in the nature of the factors considered.

In most cases these factors are designed based with an understanding that future establishments of the link between design and manufacture can be undertaken at later stage. This is not always the case.

That such selection method are designed based can be illustrated by considering a typical CADCAM check list, shown below:

TEXT FONT
SYSTEM PROCEDURES
MODE 20, 30
DESIGN ANALYSIS
NC OUTPUT
DIMENSIONING
MANIPULATION
CONSTRUCTION

This is a summary of a more extensive checklist which contain a total of 120 individual items, of which 20 may be said to encompass the manufacturing field. In this instance there is a section titled system procedures which includes the establishment of a database and associated management system, and the development possible in terms of Networking the system with existing and future installations. As such, this check list is superior to many particularly since it is contained in a publication which proceeds to adequately cover the important manufacturing functions, such as process planning and production control, which may be included in the development of the final integrated manufacturing system.

As a consequence full integration was not possible. However, in attempting to solve the problem of data transfer from one system to another the company recognized that an effective CAD facility could be developed using their purchased CAM system, and therefore removed the need for complicated data transfer. The CAD facility resulting was very basic allowing the destruction of two dimensional shapes, but by using their powerful three dimensional modeling system to develop their product and output the final two dimensional shapes. The manufacturing capabilities have reached the required level.

The use of a basically CAM based system for design purposes is no longer an ineffective option. There is a continuing development of CADCAM system which exhibit a particular bias in either design or manufacturing, but which are capable of both. This means that it is essential for prospective user to appreciate fully the capabilities of the available system and select accordingly.

3.2 EFFECTIVE USE OF CAD/CAM.

There are many excellent applications of CAD/CAM and Computer-based engineering technology particularly in those ones which integrate the manufacturing processes. However, there are still many companies who have not fully realized this potential. To improve the overall business impact of the technology an effective foundation is essential for its implementation and use the development of a comprehensive strategy as part of this foundation which are the key elements of people, organization, method and technology. Other factors are also considered for example education and training, continuous appraisal and the need for visibility throughout the company.

Providing a foundation for the effective use of CAD/CAM and Computer based engineering system is essential for their overall success. Although there have been some excellent applications of the use of CAD/CAM many of the benefit have been "localized" or "departmental" and have not fully realized the full potential of total design to manufacture integration.

A number of clear messages are beginning to emerge from the body of CAD/CAM users. CAD/CAM is no longer new and there is an expanding breed of toughened "second generation" users with raised expectations demanding excellence not just in technical functionality but in integration capabilities, data management and user support to name but a few.

The need today is very much geared to "what new method of working will CAD/CAM introduce for the benefit of the business", and not "what productivity improvements can I expect over manual method".

There is a growing body of opinion that recognizes that there must be a well defined strategy in place to provide the foundation and vision needed for the implementation of the new technology.

3.21 ELEMENT OF THE STRATEGY

One of the most important consideration is to identify what the strategy should contain in terms of the applicability and scope many companies will claim to have some form of "CIM Strategy". Often this is little more than the familiar broad brush statements such as "reduce lead times", reduce cost, "increase flexibility" and "improve quality". Admirable statements but they often fall far short at the next level of detail by providing little or no information about how these statements can be applied to the business. For example, some companies adopt the myth that if a certain intended action can be seen as reducing lead time, cost, etc, then it is deemed to satisfy the CIM strategy and therefore justified. Either companies adopt a "mouthpiece" strategy which is so far removed from reality that its only used is to be "disted down" and presented on prestigious occasions.

The strategy should be alive and working and truly represent the business needs for today and the future. There are four very clear and distinct elements of the strategy as follows:

(A) People

(B) Organization

(C) Method

(D) Technology

(A) PEOPLE:- Investment in people skill and engendering the attitude and establishing the frame work that will make people "want to come to work" is the key strategic objective. Typically, there are four groups of people which need to be addressed by the strategy.

(b) Users – "The agents of change" – Apply the new technology to the engineering processes.

(c) Support – The tools of change" guide the application of the technology and provide focused support to management and users during the change process.

(d) Management – Catalyst of change – Responsible for the overall direction and resource allocation. They must exchange existing outdated processes and instill the acceptance of new method of working particularly in the area of engineering and manufacturing integration.

(e) Implementation – "The controller of change" – In the form of a project team, provide a flexible force to implement the strategy according to agreed milestone and plans.

(B) ORGANIZATION

In many organizations, particularly where the design and engineering functions is complex or project oriented the organization will have to satisfy both functional and matrix relationships. 4 matrix organization is usually employed to ensure that the strategy is implemented across the functional areas. Three groups can be identified.

(i) Functional management : ensure that the day to day responsibility and ownership of the strategy remain firm.

(ii) Implementation organization: support the implementation in the functional areas, and call on the active support from the user.

(iii) Standard and procedure :provide the working interface between the users and the system elements they effectively provide the "how to" in the working environment and ensure that all staff work in a consistent manner.

(A) METHOD

The method relates to the entire engineering process. The engineering process can be thought of as comprising of two main activities.

(i) Product definition – which defines the functional design of the product, for example, its structural integrity and physical attributes, which, is usually in the form of graphics with supporting textual information.

(ii) Process definition – Define how the product is made, for example its assembly structure and manufacturing operation.

Computer-based engineering technology could bring business perspective and engineering perspective when developing the new methods of working.

(B) TECHNOLOGY

The technology element which need to be addressed as part of an overall strategy.

(i) DATA – The form and information content of data is paramount. The control and access of data is particularly important. It is particularly evident that many companies seem to survive on "pre-release" engineering information. Computer-based systems will enforce far stricter disciplines on the control and access of data. The communication of data to all requesting functions and users is also important and dependence on traditional drawing will decrease in favour of the "engineering work package" which will contain much more specific information for the task in hand.

(ii) SOFTWARE – The software environment provides the first level of control over data. This relates to how the data is structured. For example, in the form of a relational database, the application tools and the operating system environment. Software development must be capable of supporting the broad base of application requirement and must be proven, stable and offer maximum integration potential.

(iii) HARDWARE – It current trends continue there raw computer processing power will be more provided in the form of more powerful and more widely distıibuted engineering work-station rather than host based. system. This gives the user greater processing power, more autonomy and an ability to access several application on disparate system concurrently. A guiding principle in hardware selection should be tour and easily upgradeable system with minimum obsolescence.

(iv) NETWORK – Development in networking and having radical layout on the design and configuration of system. Different hardware platform can reside on the same network that gives improved access to data and software.

3.3 ANALYSIS OF CAD/CAM SYSTEM FOR CAM MECHANISM

System analyst is defined as the method of determining how best to use computer with other resources to perform task which meet the information need of an organization. The individual who carry out the process of analyzing and designing a system is called the Systems Analyst. The systems analyst must work with the user of the system, program and/or supplier of the software/hardware of the organization. The analyst must also carefully examine the existing system to be able to identify its strength and weakness. This helps the analyst in developing a functional and effective system capable of solving the problem in determining the performance of the existing system.

Before the system analyst finally creates the new system, the specification of the user requirement must be approved by the management and interpreted by the analyst to create one or more system specification, which provide detailed documentation of the entire system.

Computerization of Cam design mechanism although they present a low degree of flexibility are frequently used, due to low cost. The Cam geometry is dictated by the technical feature of the process to be automated.

The method for designing Cam mechanism with the aid of a computer aided method, so efficient and functional system developed, so efficient and functional system developed for this study is in the form of a program which uses one of the most powerful software application system called VISUAL BASIC: Visual Basic is a versatile programming language for developing system for various applications in engineering organizations.

Visual Basic is the easy way to write program for windows. Because it gives maximum control over your computer, programs can automate your work, preventing mistakes and making you more productive. When typing visual Basic code, you don't usually have to worry about capital or lower case letters. Visual Basic is not case sensitive.

The system has been developed such that it interact with a visual basic file which accept and stores the data relating to the application for Cam mechanism design

Designing a Cam mechanism is not an easy task in construction of the displacement graph and Cam graph. The designer has to know the follower motion, in the construction and the study of Cam, a displacement diagram or Cam graph is used. The displacement or lift of the Cam follower plotted against the angular displacement of the Cam. The Cam usually rotate at constant speed so that equal amount of angular displacement occur in equal interval of time. The follower however is required to start and finish it strike at rest thereby having variable velocity. Furthermore, it often remain at rest during some part of the Cam rotation, this is known as a period of dwell.

There are four types of motion usually considered during the construction of displacement graph and Cam profile, which are uniform velocity, uniform acceleration and retardation, simple Harmonic and dwell.

3.32 CONSTRUCTION REQUIREMENT

Construction of the displacement graph or Cam profile, the designer has to know

(a) Type of follower

(b) Type of motion

(c) Uniform velocity motion

(d) Uniform acceleration/retardation motion

(e) Simple Harmonic motion

(f) Dwell

(g) Angular displacement of the Cam.

(h) Displacement lift or fall.

(i) Least radius of the Cam.

All these have to be constructed using a drawing sets. Going through these rigours, there is need for a very reliable and efficient system for designing Cam mechanism, which will give you your displacement graph and Cam profile by the use of the micro Computer based.

3.33 WEAKNESS OF THE EXISTING SYSTEM

Looking inwardly at the existing system of construction of Cam mechanism a lot of things are observed which undermine the performance of the existing system terms of efficiency and data processing. These include

-Record and collation are labour intensive.

-Construction of the displacement graph and Cam profile is time - consuming.

-Retrieval of inter-related information could be an almost impossible task – due to large database

-Data analysis is difficult, because related information cannot be managed and calculation are done manually which subjected to error.

Data security is weak – the records could be accessed and modified easily by unauthorized persons.

No backup facility is available. A loss of files and records means a total loss.

There is a reason for new system. After examining all these impediments caused by the manual way of construction of displacement graph and Cam profile which are subjects to mistakes. Hence, there is need for an automated system which will take care of all these anomalies.

3.34 PROPOSED SYSTEM

The efficient and functional system developed for this study is in form of a program which uses one of the most powerful database management system software called VISUAL BASIC. Visual Basic is the easy way to write program for windows. Because of maximum control over computer, program can automate your work, it interact with the tile which accept and store the data relating to the application for Cam mechanism design.

3.35 FILE ANALYSIS/DESCRIPTION.

Under the file analysis description, it contain information on mechanism of Cam design.

MOTION:- Is the field which contain the code of the various motion i.e. Uniform velocity, Simple Harmonic Motion, Dwell, and Uniform acceleration/retardation.

ANGLE TEXT:- This field store the angle of rotation for each motion performed at various stages.

HEIGHT TEXT:- This field contain the height of each motion.

RISE/FALL TEXT:- This field contain whether the motion is raising or falling.

RADIUS:- This field contain the least radius of the Cam.

ADD FIELD:- This field activated when to add new record into the file, the program is run and data supplied is automatically stored in the file.

PLOT 1 FIELD:- Supplied the displacement graph.

PLOT 2 FIELD:- Supplied the Cam profile.

3.4 INPUT DESIGN

The Visual Basic discussed above are regarded as the input files which contain data required for the designing of Cam mechanism by the Computer to produce the required output. Below are some of the examples of the Input design.

3.5 OUTPUT DESIGN

The execution of the input of a program result to the output which is the information or response expected. The output can either be "soft" or "Hard". The soft copy of the output refers to the result on the computer's screen while the hard copy of the output is the printed report or information on paper. The reports expected to be produced from the program execution are:-

(i) Displacement graph

(ii) Cam profile.

This report are meant to assist Cam manufacturer to take quick decisions and fast the rate of production.

Below are samples of the output execution from the example of the input data.

3.6 REQUIREMENT SPECIFICATION FOR MECHANISM CAM DESIGN SYSTEM.

HARDWARE REQUIREMENT.

(1) A CD-ROM drive

(2) At least 24 MB of RAM (Memory)

(3) At least 48MB of free disk space

(4) A Pentium PC running window 95 Windows 98 or NT

(5) Printer – laser jet

(6) Input Device

(a) CD-ROM

(a) Disk drive – 3.5" floppy disk drive

(b) Key board in standard key board (IBM)

(c) Power saver of up to 1000NV.

SOFTWARE REQUIREMENT

1.Visual Basic VI Package

2.Microsoft Disk

3.7 COST AND BENEFIT ANALYSIS

A COST ANALYSIS

Developmental Cost

2	PC (486 DX)	40,000
2	NV KEYBOARD	2,000
2	LASER JET	90,000
2	UPS (1000NV)	50,000
Miscellaneous expenses		35,000
	TOTAL	**217,000**

SOFTWARE COST

Word processing (6.1 version)	20,000
Visual Basic Programs	20,000
Spread sheet	10,000
Windows 98	10,000
TOTAL	**60,000**

OPERATING COST

System Analysis of Design for	
4 Wks at 10,000 per wk	40,000
Installation Cost	20,000
Training	50,000

Utilities	40,000
Maintenance	40,000
2 Airconditioner (2 H.P.)	80,000
Miscellaneous	40,000
TOTAL	**310,000**

TOTAL COST ANALYSIS

Development cost, software cost + Operational Cost

Total Cost Analysis = 5877,000.

B BENEFIT ANALYSIS

(a) Large volume of data can be handled easily.

(b) Data security and protection will be ensured.

(c) Comparative analysis can easily be made from available data since data would be not be centrally controlled.

(c) Easy accessibility to past data make forecasting and planning simpler./

(d) Data can be processed faster than was formally done.

CHAPTER FOUR

SYSTEM DOCUMENTATION AND IMPLEMENTATION

4.1 PROGRAMMING LANGUAGE USED.

The choice of programming language is an important factor to be considered when developing a new system. Visual Basic was chosen as the language to be used, due to its vast features, ideal for a database system. V basic is a database package developed by visual basic software. It is a data base software which offer powerful features and tools for developing user-defined software. The features of V basic includes the following.

-V basic 6 has a completely simplified menu and commands presentation unlike in other database software.

-V basic 6 form code to be written as much as possible in a modular form, with each screen menu, report form having a separate module for coding. This would enable the logic programme to be easily understandable, maintained and updated for feature purposes.

- V basic 6 provides editor's and form-design tools that enable the programmer to interactively create and modify programs queries, menus, data entry screens, reports and labels.

It is possible to easily develop complete pull-down menu driven programmer's with mouse compatibility to further consume a user friendly atmosphere.

-It has a great interface with windows application and provide network capabilities.

-V basic 6 include tracing and debugging facilities which enables easy debugging of codes and easy maintenance.

-Visual Basic is the easy way to write program for windows. Simply, because it gives you maximum control over your computer programs can automate your work, preventing mistakes and making you more productive.

Writing programs can be complex, but fortunately visual basic makes it easy to get started. You can choose how far to go. Another advantage of visual Basic is that it works with Microsoft office and on the internet./

4.2 USER'S DOCUMENTATION.

This section is basically meant for the user's of this software. For a successful rum of the program of this, the user should use the procedure described below:

(a) Turn on the computer by using the button or switch provided.

(b) Installing Visual Basic is done by running the program SETUP. EXE. CD-ROM version, this usually runs automatically when the CD is inserted into the drive.

(c) Start visual Basic and make sure that "standard EXE" is highlighted in the opening dialog, then click open box.

(d) Find the small window called properties and click in the box to the right of caption type "my first application" and press Return; watch the title of the form change.

(e) Click the small right arrow to run the application.

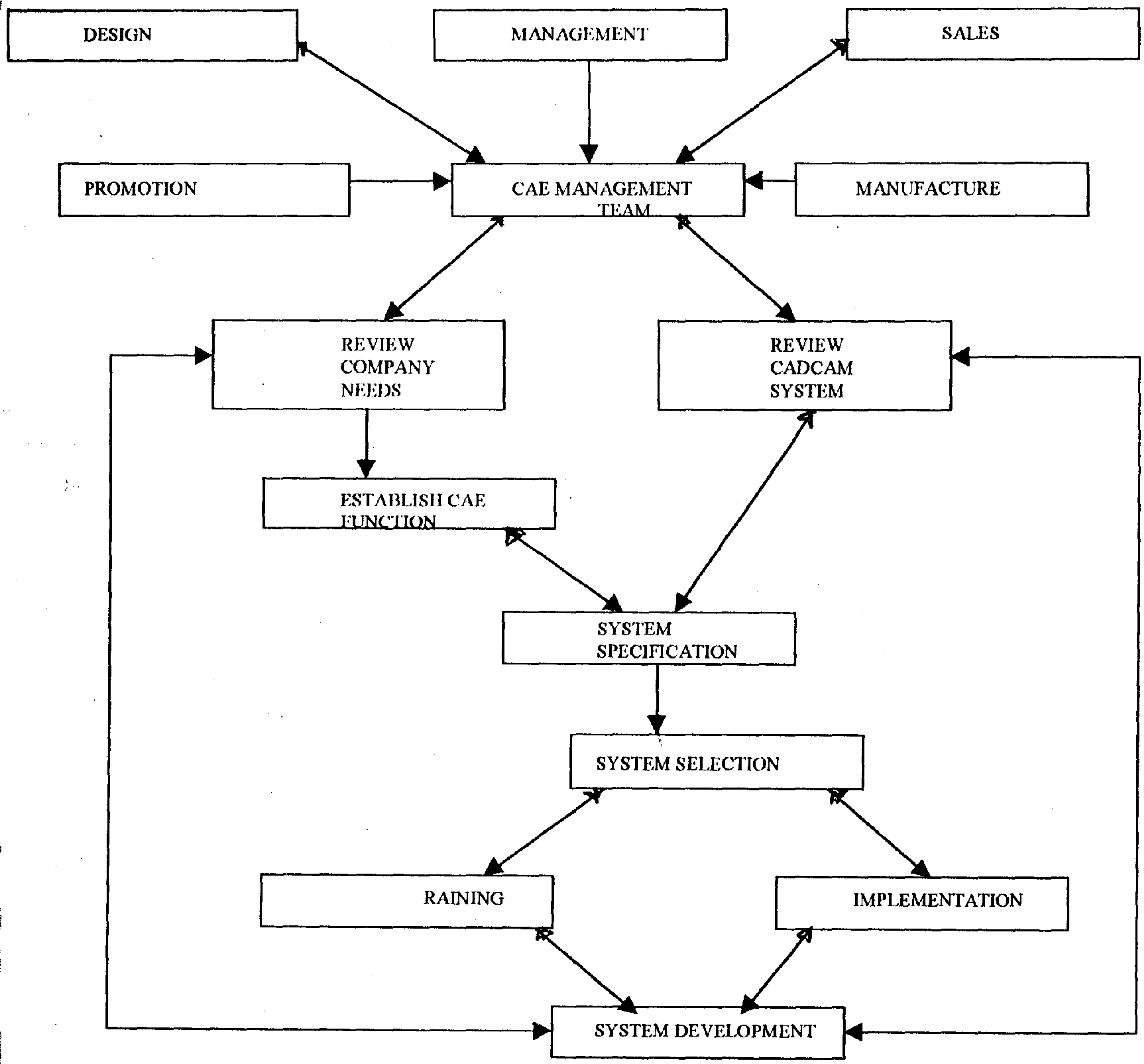
The program for this particular Cam mechanism is on CD-ROM version. It runs automatically when the CD is inserted into the drive. It displaces the table which data are input. From the table there Add box, plot 1 and plot 2 which after the input of the data, click the plot 1 it shows the displacement diagram of graph, while the plot 2 displace the Cam profile.

4.3 SYSTEM IMPLEMENTATION.

Successful implementation to reach the stage where all machine tool programming is based upon the transfer of data from design to manufacture. Including the consultation and training of staff, forward planning and an associated gradual development of the system ensuring that the system grew as the company's know how increased. A general implementation is represented in Fig. The exact nature of the approach will depend upon many factors including financial and human resources available, current manufacturing and design method, and future development plans of the company.

The fig. one suggests that successful implementations should begin with the establishment of a computer aided sufficiency management team. The team must consider the implications of the implementation upon relevant department. Although the dependence upon common system described, the important consideration in CADCAM implementation, that existing system whether they are designed or manufacturing based, must be incorporated into an overall system plan. At this point, careful planning is needed to ensure that the system is integrated into the company in a well controlled and ultimately successful manner. This will depend upon the gradual introduction of the system to the user's with key staff trained to provide areas of know how within the department from which knowledge may be distributed.

The prime objective of CADCAM is raising the level of industrial performance by the effective use of academic resources. Improve manufacturing and industrial methods by the effective implementation of advanced technology. It gives academic staff broad and direct involvement with industry to benefit research and enhance the relevance of technology advancement.



GENERAL IMPLEMENTATION CHART

4.4 SYSTEM MAINTENANCE.

A system requires constant maintenance for it to be functional at all time. Failure to keep it operational and effective can lead to inefficiency and many other problems. The following measures should be observed:-

(i) The program should be kept virus free

(ii) Backup copies of the program should be made and kept secured.

(iii) The system should be properly handled as well as the CD or the disk in use.

(iv) Modification should be made when necessary.

4.5 TRAINING OF STAFF

Education and training will play a major role during the implementation. This includes preparing a detailed programme for education on a company wide basis. The first task will be to identify the target groups for training and then to prepare individual training programs to support their requirements. It is more beneficial if most of the training is conducted in-house and with maximum participation from the user management and skilled user. External support will often be required for more specialist applications and to ensure that the standard for education and training are compliant with the latest industry practices. There is a massive requirement to educate all staff in the basic principles and concepts of the new technology as well as concentrating on the company method of working rather than just on purely technical skill.

The systems analyst would be required to ensure that all persons involved with the new system are capable of making it an operational success. The amount of training required for various categories of personnel will depend upon the complexity of the system and the skill presently available.

4.6 SYSTEM TESTING

There is need to ensure that the individual programs have been written correctly and that the system as a whole will work. To this end, the system analyst must provide the necessary test data for program testing as well as procedure testing. This is to ensure that all possible contingencies as specified in the system specification have in fact been catered for by the programmer expected result of the test must be work out before hand for comparison purposes. The aim of procedure testing is to ensure that the whole system fits together as planned.

4.7 PROGRAM MODULE

Under this section, a written description of the program is done, after the program has already been tested, implemented and documented. This makes any system being designed to be a complete system. However, there are a total seven program modules which make up the new design system. These are:-

(i) MODULE 1

(ii) CAM FORM CODES

(iii) FORM SPLASH CODES

(iv) PLOT 1 FORM CODES

(v) ADD FORM CODES

(vi) CLASS MODULE

(vii) PLOT 2 FOR CODES

4.71 (I) MODULE 1

This is the main program, which contain all the other sub programs that are used in the software.

The following programs exist within the module program.

(a) DIRECTION RISE/FALL – Is the program that shows whether it is rise or fall of the motion Cam.

(b) MOTION – It is the case type of motion repaired at various stages of the Cam rotation i.e. simple Harmonic motion, Uniform velocity, uniforms acceleration/retardation and Dwell.

(c) ANGLE – It stores the angular data at various displacements of the angular rotational of the motion.

(e) HEIGHT – Enter the height of displacement at each angular rotational of Cam.

(2) CAM FORM CODE – Is the program that input the various type of motion, angle light and direction in their proper columns and rows.

(3) FORM SPLASH CODE – This program activated all the code, variable, screen, mouse pointer to run the supplied data which are stored in the file automatically.

(4) PLOT 1 FORM CODE – Program that plot the displacement graph of the motions.

(5) ADD FORM CODE – This is activated when intended to add new record into the file. The program is run and data supplied which is automatically stored in the file.

(6) CLASS MODULE – Program that define the object code, is know as the class code, each class has its own code module.

(7) PLOT 2 FORM CODE – Program that write the code object properties for plotting the cam profile.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

The Computerization of Cam mechanism design system, was designed to assist the mechanical production firm in their operations in terms of Cam mechanism design and also in the monitoring reliable and better results. The system was designed to handle all types of Cam mechanism that has the form type of motion discussed in this project.

5.2 CONCLUSION

The computerization of Cam mechanism design system, will make work of mechanical production firm more easier in the processing of information and monitoring the manufacturing operation. The system will go a long way in ensuring proper monitoring or inspecting Cam manufacturing processes enhancing efficiency and ability to handle large work, and reduce cost and time.

There are many excellent application of computer aided Design (CAD) and Computer-based engineering technology particularly in those areas which integrate the manufacturing process. However, there are still many companies who have not fully realized the potential. To improve the overall business impact of the technology an effective foundation is essential for its implementation and use.

In conclusion, the importance of the use of the computerized system in mechanical production industry for the processing of Cam mechanism design cannot be over-emphasized. Mechanical Engineering manufacturing firm has contributed more significantly in the development of technological sector, which provide the economy with some of the basic needs.

5.3 RECOMMENDATION

In view of the above, this project is recommended to all the mechanical engineering manufacturing firms for an effective Cam mechanism design system.

However, information held within a computer can be subjected to loss through errors made by the user, using it or the system. I therefore recommend that concerted efforts be made towards data security, maintenance of machinery especially the hardware, making backups for the software, as well as giving regular training to the personnel and their welfare.

Likewise, preparation should be made towards unforeseen expenses especially because of the trend in hardware configuration and also changes that are likely to be made on software and the use of input and output material to meet up the desired objectives.

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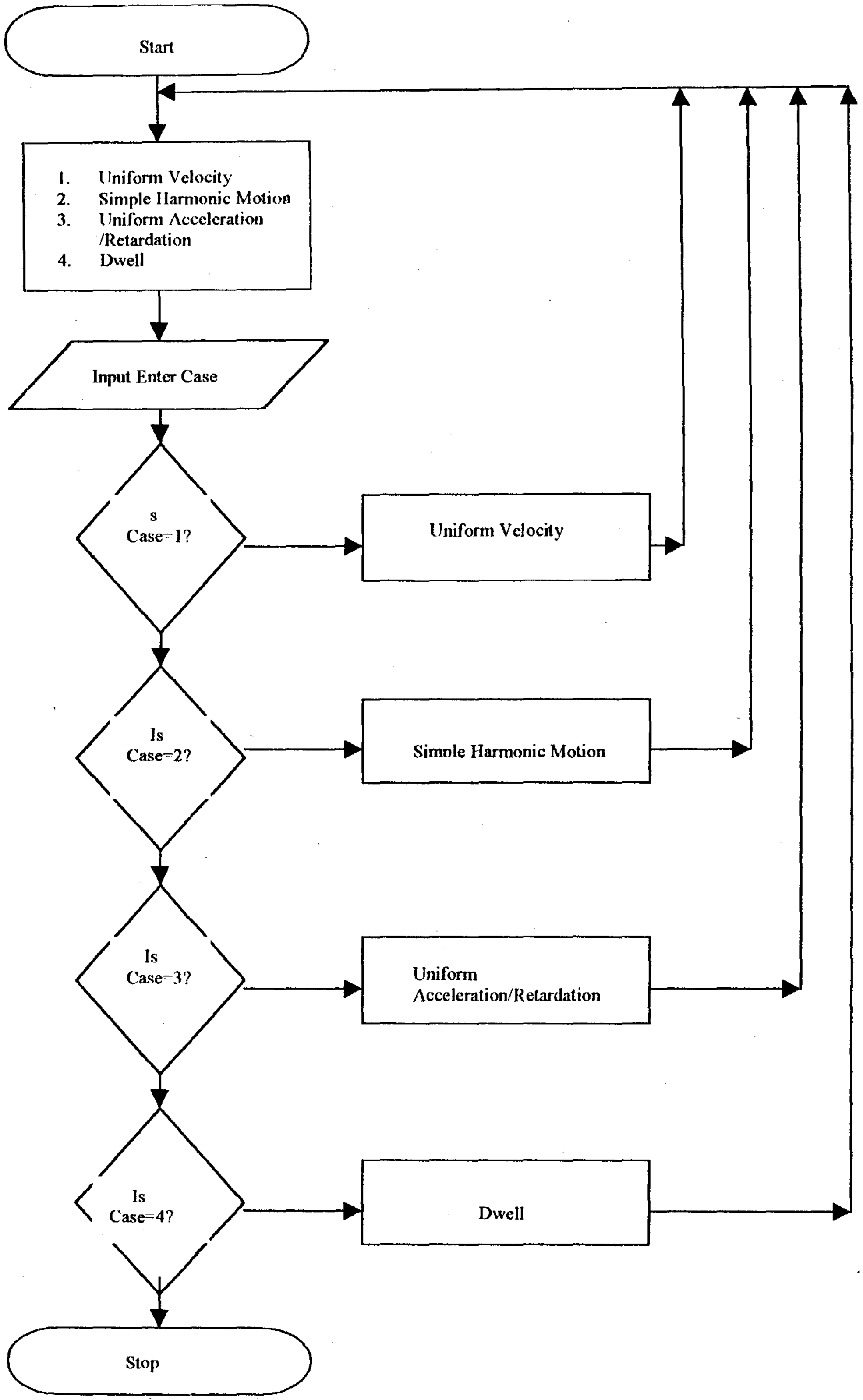
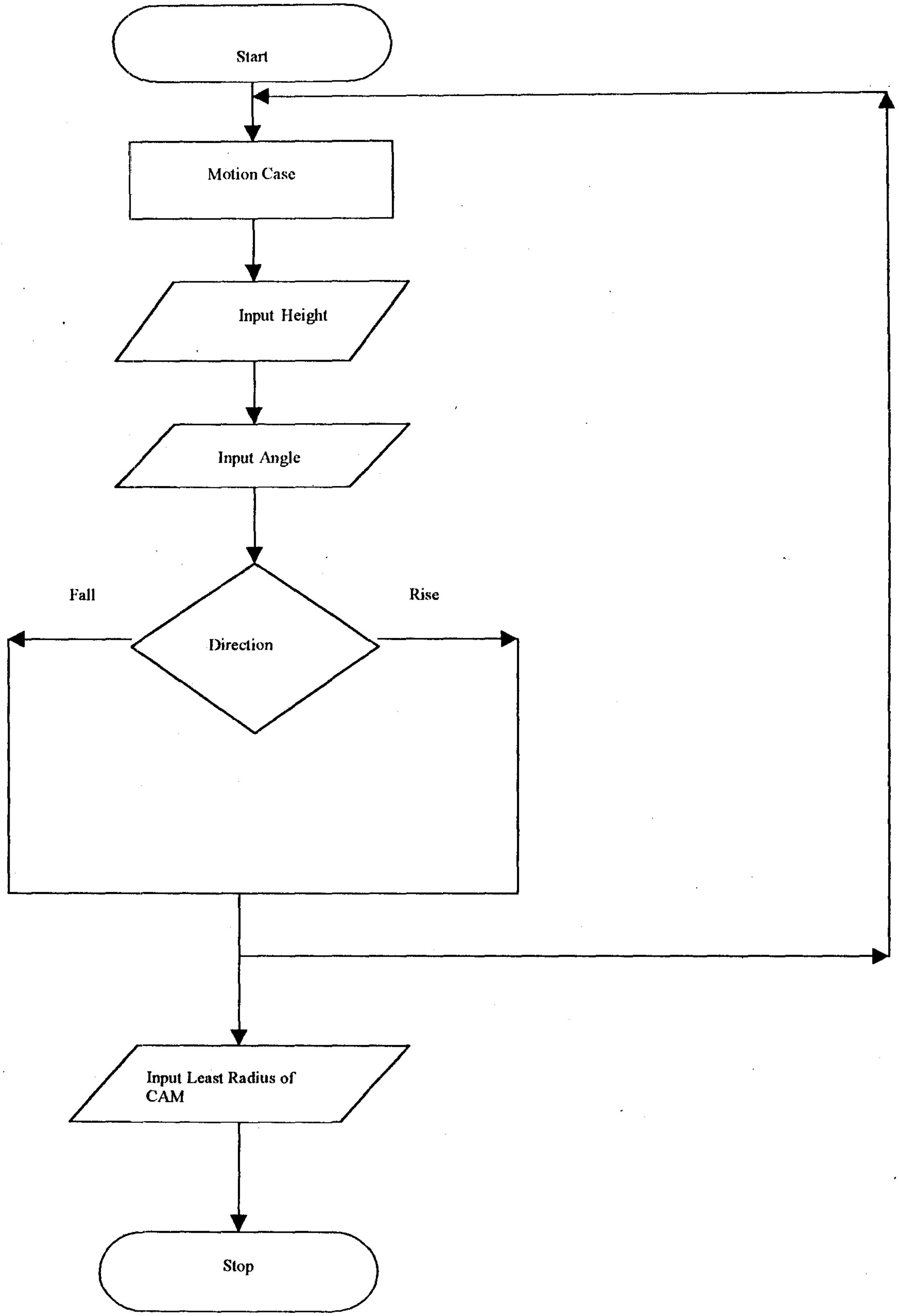


Start
1. Uniform Velocity
2. Simple Harmonic Motion
3. Uniform Acceleration /Retardation
4. Dwell
Input Enter Case
s Case=1?
Uniform Velocity
Is Case=2?
Simple Harmonic Motion
Is Case=3?
Uniform Acceleration/Retardation
Is Case=4?
Dwell
Stop


Start
Motion Case
Input Height
Input Angle
Fall
Rise
Direction
Input Least Radius of CAM
Stop

MODULE 1

```
Option Explicit

Enum RF
Rise
Fall
End Enum

Type MyPoint
X As Single
Y As Single
End Type
Public Radius As Single
Public CurPoint As MyPoint
Public Points(-1 To 1000) As MyPoint
Public T As Scam
Public Ts As Collection
Public Index As Integer

Public Sub Main()
Set T = New Scam
Set Ts = New Collection
frmSplash.Show (vbModal)
Cam.Show
End Sub

Public Sub Dwell(S As Scam)
If Index = 0 Then
   For Index = Index To Index + S.Angle / 5 '- 1
      Points(Index).X = Points(Index - 1).X + 5  'S.Angle
      Points(Index).Y = CurPoint.Y
   Next Index
Else
   For Index = Index To Index + S.Angle / 5 - 1
      Points(Index).X = Points(Index - 1).X + 5  'S.Angle
      Points(Index).Y = CurPoint.Y
   Next Index
End If
CurPoint.X = Points(Index - 1).X
CurPoint.Y = Points(Index - 1).Y
End Sub

Public Sub UV(S As Scam)
Dim m As Single
```

```
Private Sub OK_Click()
Set T = New Scam
T.Motion = MotionCombo
T.Angle = AngleText
T.Height = HeightText
If Option1.Value = True Then T.Direction = Rise
If Option2.Value = True Then T.Direction = Fall
Unload Me
End Sub

Private Sub UpDown1_Change()
AngleText = UpDown1.Value
End Sub
```

CAM FORM CODES

```
Option Explicit
Private Sub AddCommand_Click()
AddForm.Show (vbModal)
If T.Motion <> Empty Then
   Ts.Add T
   MSFlexGrid1.Row = MSFlexGrid1.Rows - 1
   MSFlexGrid1.Rows = MSFlexGrid1.Rows + 1
   MSFlexGrid1.Col = 1: MSFlexGrid1.Text = T.Motion
   MSFlexGrid1.Col = 2: MSFlexGrid1.Text = T.Angle
   MSFlexGrid1.Col = 3: If T.Direction = Rise Then MSFlexGrid1.Text = "Rise" Else
MSFlexGrid1.Text = "Fall"
   MSFlexGrid1.Col = 4: MSFlexGrid1.Text = T.Height
   MSFlexGrid1.Col = 0: MSFlexGrid1.Text = Empty

   MSFlexGrid1.Row = MSFlexGrid1.Rows - 1
   MSFlexGrid1.Col = 0: MSFlexGrid1.Text = "Total"
   MSFlexGrid1.Col = 2: MSFlexGrid1.Text = TOTAL
End If
End Sub
Function TOTAL()
Dim i As Integer
MSFlexGrid1.Col = 2
For i = 1 To MSFlexGrid1.Rows - 1
   MSFlexGrid1.Row = i
   TOTAL = TOTAL + Val(MSFlexGrid1.Text)
Next i
End Function

Private Sub ClearCommand_Click()
MSFlexGrid1.Clear
```

```
MSFlexGrid1.Rows = 2
Set Ts = Nothing
Set Ts = New Collection
MSFlexGrid1.Row = 0
MSFlexGrid1.Col = 1: MSFlexGrid1.Text = "Motion"
MSFlexGrid1.Col = 2: MSFlexGrid1.Text = "Angle"
MSFlexGrid1.Col = 3: MSFlexGrid1.Text = "Direction"
MSFlexGrid1.Col = 4: MSFlexGrid1.Text = "Height"
End Sub

Private Sub ExitCommand_Click()
Unload Me
End Sub

Private Sub Form_Load()
MSFlexGrid1.Row = 0
MSFlexGrid1.ColWidth(1) = MSFlexGrid1.ColWidth(1) * 2
MSFlexGrid1.Col = 1: MSFlexGrid1.Text = "Motion"
MSFlexGrid1.Col = 2: MSFlexGrid1.Text = "Angle"
MSFlexGrid1.Col = 3: MSFlexGrid1.Text = "Direction"
MSFlexGrid1.Col = 4: MSFlexGrid1.Text = "Height"
End Sub

Private Sub Plot2_Click()
Plot2frm.Show (vbModal)
End Sub

Private Sub PlotCommand_Click()
PlotForm.Show (vbModal)
End Sub
```

FORM SPLASH CODES

```
Option Explicit

Private Sub Form_KeyPress(KeyAscii As Integer)
   Unload Me
End Sub

Private Sub Form_Load()
Screen.MousePointer = 11
Timer1.Enabled = True
End Sub

Private Sub Form_Unload(Cancel As Integer)
```

```
Function Theta(i As Integer)
Theta = Points(i).X + 90
End Function
```

PLOT FORM CODES

```
Option Explicit

Private Sub Form_Load()
Dim i As Integer
Scale (-10, 100)-(400, -10)
Line (-10, 0)-(400, 0), RGB(255, 0, 0)
Line (0, 100)-(0, -10), RGB(255, 0, 0)
CurPoint.X = 0
CurPoint.Y = 0
Points(-1).X = -5
Index = 0
Dim obj As Scam
For Each obj In Ts
   Select Case obj.Motion
   Case "Dwell": Dwell obj
   Case "Simple Harmonic Motion": SHM obj
   Case "Uniform acceleration/retardation": UAR obj
   Case "Uniform Velocity": UV obj
   End Select
Next obj
For i = 0 To Index - 2
   Line (Points(i).X, Points(i).Y)-(Points(i + 1).X, Points(i + 1).Y), RGB(0, 0, 0)
Next i
End Sub

Private Sub Form_MouseDown(Button As Integer, Shift As Integer, X As Single, Y As
Single)
Debug.Print X, Y
End Sub
```

ADD FORM CODES

```
Option Explicit

Private Sub Cancel_Click()
T.Motion = Empty
Unload Me
End Sub
```

```
If S.Direction = Rise Then m = 1 Else m = -1
m = m * S.Height / S.Angle
If Index = 0 Then
   For Index = Index To Index + S.Angle / 5
      Points(Index).X = Points(Index - 1).X + 5  'S.Angle
      Points(Index).Y = m * (Points(Index).X - CurPoint.X) + CurPoint.Y
   Next Index
Else
   For Index = Index To Index + S.Angle / 5 - 1
      Points(Index).X = Points(Index - 1).X + 5  'S.Angle
      Points(Index).Y = m * (Points(Index).X - CurPoint.X) + CurPoint.Y
   Next Index
End If
CurPoint.X = Points(Index - 1).X
CurPoint.Y = Points(Index - 1).Y
End Sub
Public Sub UAR(S As Scam)
Dim i As Integer
Dim a As Single, U As Single
a = 2 * (S.Height / 2) / (S.Angle / 2) ^ 2
If S.Direction = Fall Then a = -a
For i = 0 To 4
   Points(Index).X = CurPoint.X + i * S.Angle / 8
   Points(Index).Y = CurPoint.Y + (a * (i * S.Angle / 8) ^ 2) / 2
   Index = Index + 1
Next i
U = a * Points(Index - 1).X
a = -a
CurPoint.Y = Points(Index - 1).Y
For i = 5 To 8
   Points(Index).X = CurPoint.X + i * S.Angle / 8
   Points(Index).Y = CurPoint.Y + U * ((i - 4) * S.Angle / 8) + (a * ((i - 4) * S.Angle / 8)
^ 2) / 2
   Index = Index + 1
Next i
CurPoint.X = Points(Index - 1).X
CurPoint.Y = Points(Index - 1).Y
End Sub
Public Sub SHM(S As Scam)
Dim i As Integer
Dim AStep As Single
Dim Sign As Integer
AStep = S.Angle / 36
If S.Direction = Fall Then Sign = 1 Else Sign = -1
For i = 0 To 180 Step 5
   Points(Index).X = CurPoint.X + (i / 5) * AStep
```

```
   Points(Index).Y = Sign * R(S) * Cos(i * 3.14 / 180) + R(S)
   Index = Index + 1 'Index + S.Angle / 30
Next i
CurPoint.X = Points(Index - 1).X
CurPoint.Y = Points(Index - 1).Y
End Sub
Function R(S As Scam)
R = S.Height / 2
End Function
```

CLASS MODULE

```
Option Explicit

Public Motion As String
Public Angle As Single
Public Height As Single
Public Direction As RF
```

PLOT2 FORM CODES

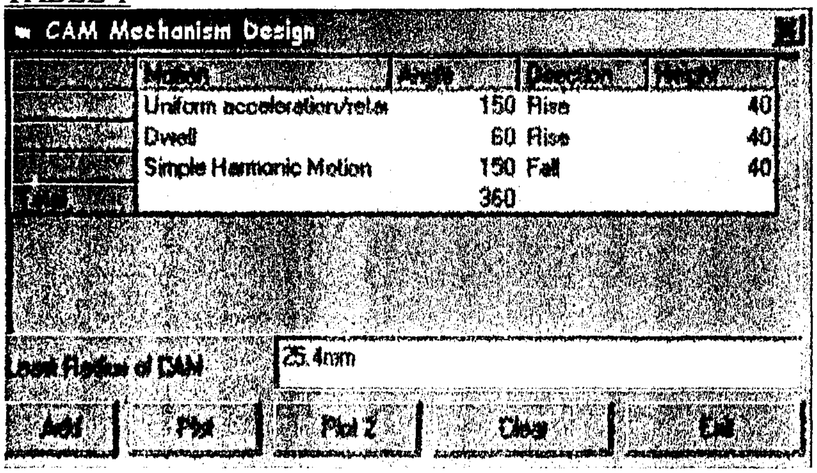
```
Option Explicit

Private Sub Form_Load()
On Error GoTo errh
Dim i As Integer
Me.AutoRedraw = True
Radius = Cam.RadiusText
Scale (-100, 100)-(100, -100)
Line (0, 100)-(0, -100), RGB(255, 0, 0)
Line (100, 0)-(-100, 0), RGB(255, 0, 0)
For i = 10 To 70 Step 10
   Circle (0, 0), i, RGB(255, 255, 0)
Next i
For i = 0 To Index - 2
   Line (R(i) * Cos(Theta(i) * 3.14 / 180), R(i) * Sin(Theta(i) * 3.14 / 180))-(R(i + 1) *
Cos(Theta(i + 1) * 3.14 / 180), R(i + 1) * Sin(Theta(i + 1) * 3.14 / 180)), RGB(0, 0, 0)
Next i
Exit Sub
errh:
MsgBox "Expected Least radius of Cam", , "Missing Parameter"
End Sub

Function R(i As Integer)
R = Points(i).Y + Radius
End Function
```

QUATION 1:

Design a plate cam to give the following motion to 25.4mm diameter roller follower

(a) 40mm lift in 150° with uniform acceleration/retardation.
(b) Dwell for 60°
(c) 40mm fall in 150° with simple harmonic motion.
(d) Line of action of follower through cam center: anticlockwise rotation.
(e) Least radius of cam 25.4mm.

TABLE 1



Motion	Angle	Direction	Height
Uniform acceleration/reta	150	Rise	40
Dwell	60	Rise	40
Simple Harmonic Motion	150	Fall	40
	360		

QUATION 2

Design a plate cam to give the following motion to a flat follower.

(a) 60mm lift for 120° of cam rotation with uniform acceleration/retardation.
(b) Dwell for 60°
(c) 30mm fall for 60° with uniform velocity.
(d) Dwell for 60°.
(e) 30mm fall for 60° with uniform velocity.
(f) Line of action through cam center: anticlockwise rotation.
(g) Least radius of cam 20mm

TABLE 2.

CAM Mechanism Design

	Motion	Angle	Direction	Height
	Uniform acceleration/reta	120	Rise	60
	Dwell	60	Rise	60
	Uniform Velocity	60	Fall	30
	Dwell	60	Rise	30
	Uniform Velocity	60	Fall	30
Total		360		

Least Radius of CAM: 20mm

Add | Plot | Plot 2 | Clear | Exit

QUATION 3:

Design a cam profile to give the following motion to a roller 25.4mm in diameter

(a) Dwell for 90° of cam rotation.
(b) Rise 40mm with simple harmonic for 75°
(c) Dwell for 30°.
(d) Fall of 40mm with uniform velocity for 75°.
(e) Dwell for remainder of revolution.
(f) Least radius 50.8mm.
(g) Line of action through center of cam: anticlockwise rotation.

TABLE 3:

CAM Mechanism Design

	Motion	Angle	Direction	Height
	Dwell	90	Rise	0
	Simple Harmonic Motion	75	Rise	40
	Dwell	30	Rise	40
	Uniform Velocity	75	Fall	40
	Dwell	90	Rise	0
Total		360		

Least Radius of CAM: 50.8mm

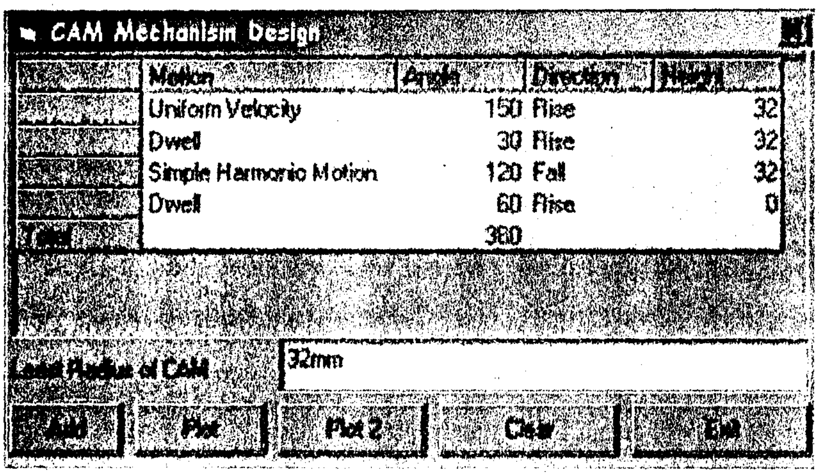
Add | Plot | Plot 2 | Clear | Exit

QUATION 4:

Design a plate cam to give the following.

(a) 150° rise of 32mm with uniform velocity.
(b) 30°dwell.
(c) 120° fall of 32mm with simple harmonic motion.
(d) 60° dwell.
(e) Line of action through center of cam: anticlockwise.
(f) Least radius 32mm

TABLE 4:



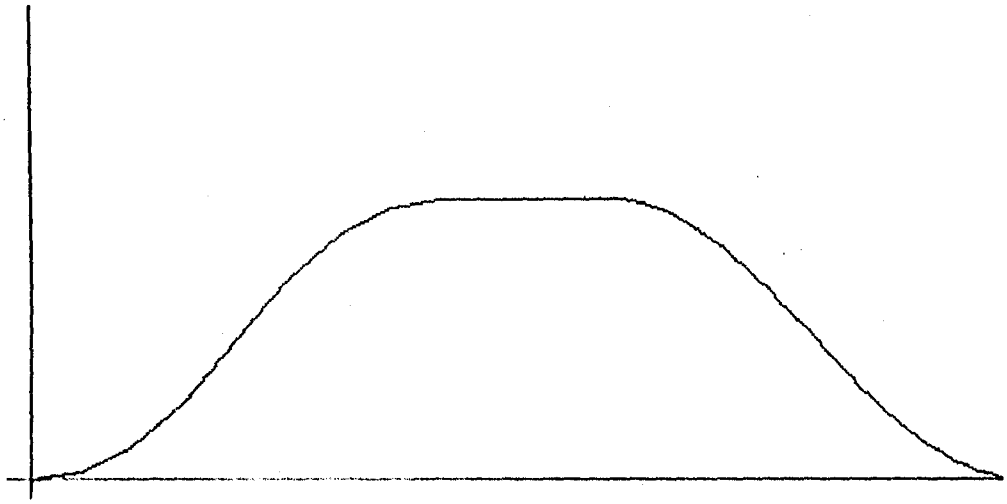
CAM Mechanism Design

	Motion	Angle	Direction	Height
	Uniform Velocity	150	Rise	32
	Dwell	30	Rise	32
	Simple Harmonic Motion	120	Fall	32
	Dwell	60	Rise	0
Total		360		

Least Radius of CAM: 32mm

Add | Plot | Plot 2 | Clear | Exit

OUTPUT TO QUATION1: PLOT 1



DISPLACEMENT DIAGRAM

OUTPUT TO QUATION 1: PLOT 2.

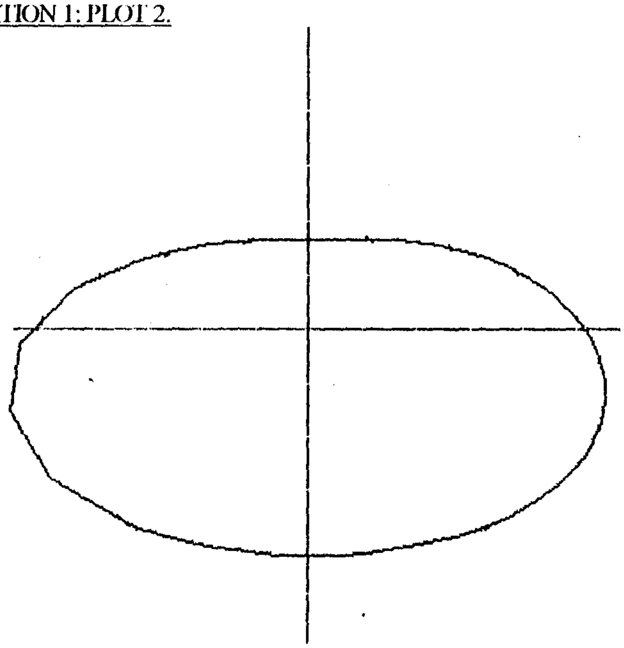
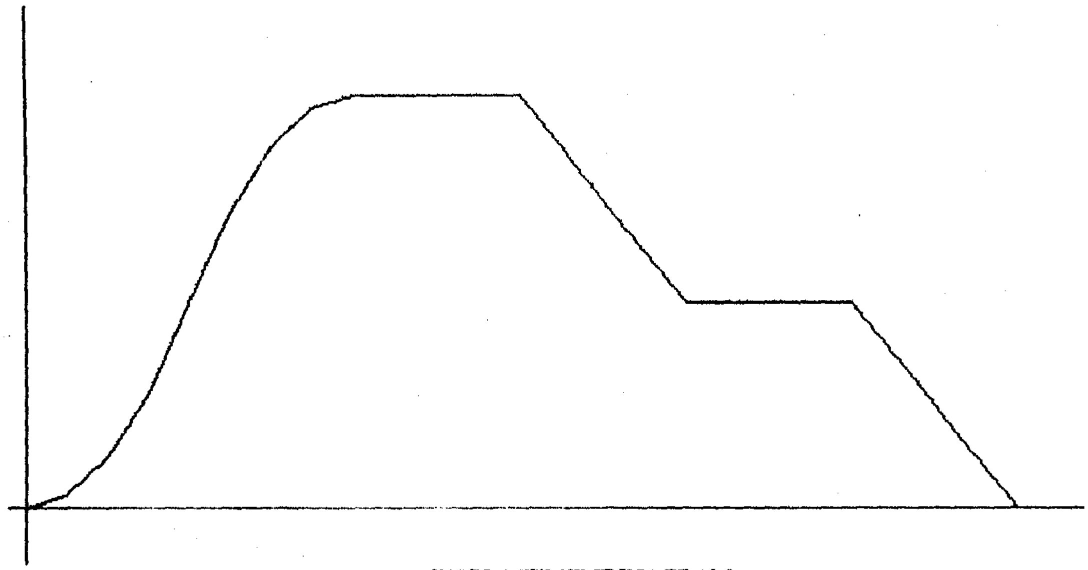


PLATE CAM DIAGRAM

OUTPUT TO QUATION 2: PLOT 1



DISPLACEMENT DIAGRAM

OUTPUT TO QUATION 2: PLOT 2.

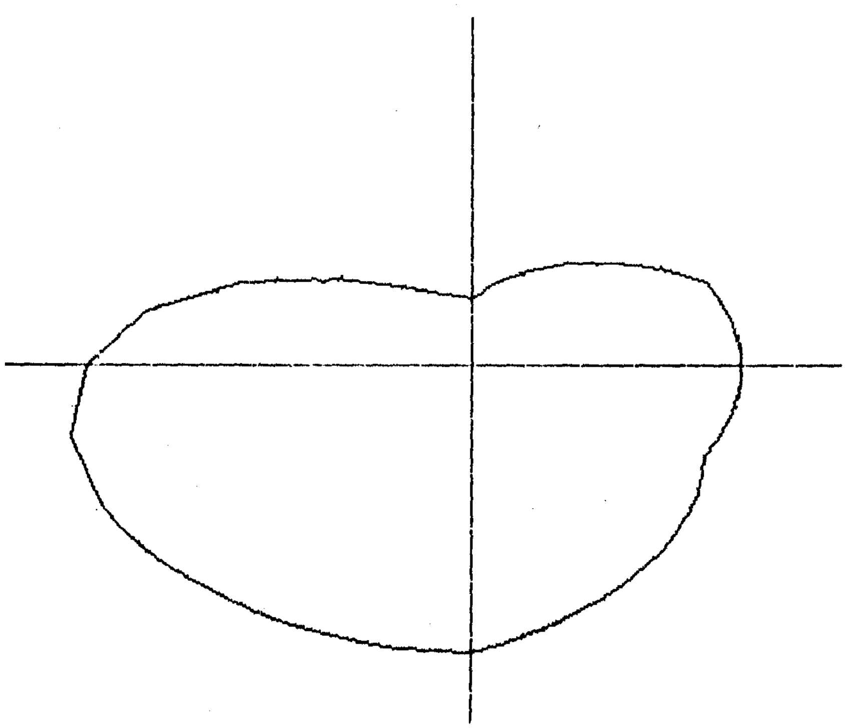
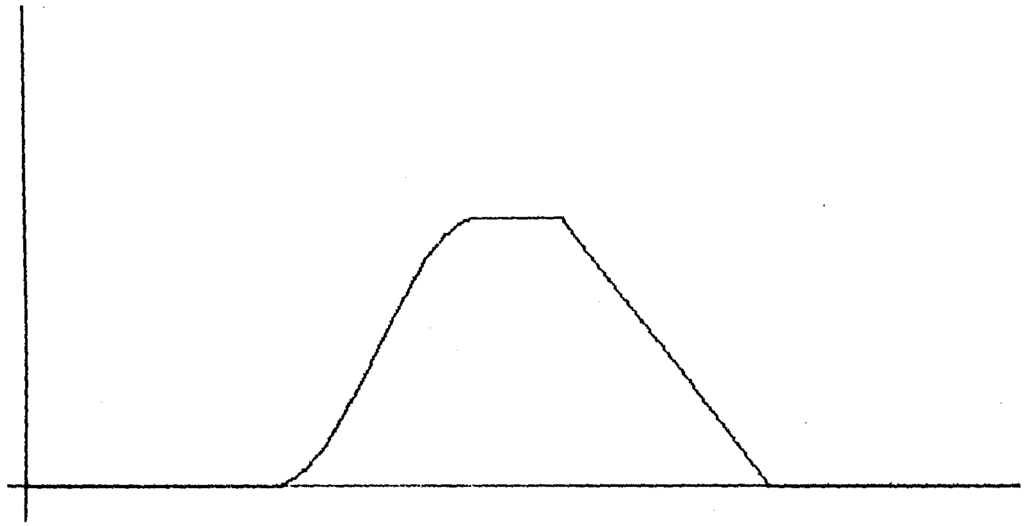


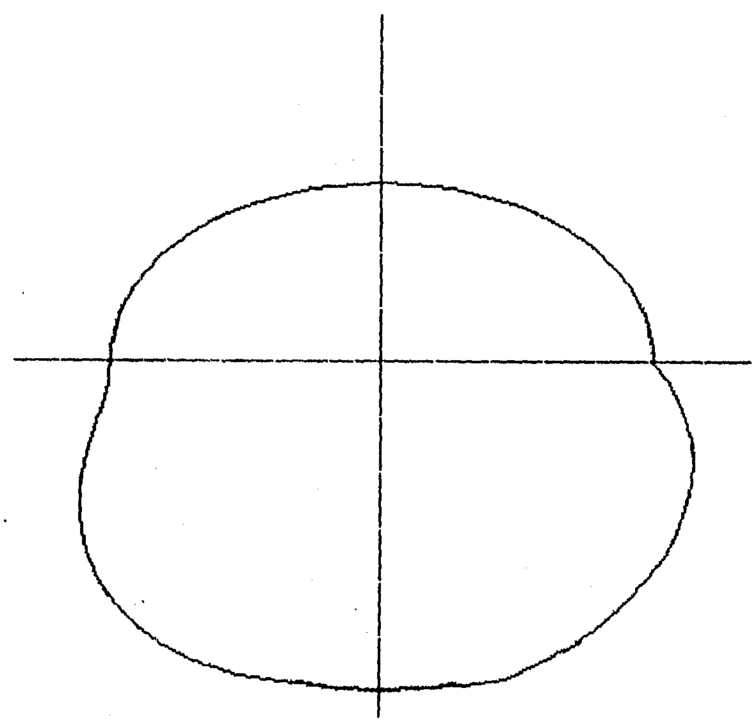
PLATE CAM DIAGRAM.

OUTPUT TO QUATION 3: PLOT1



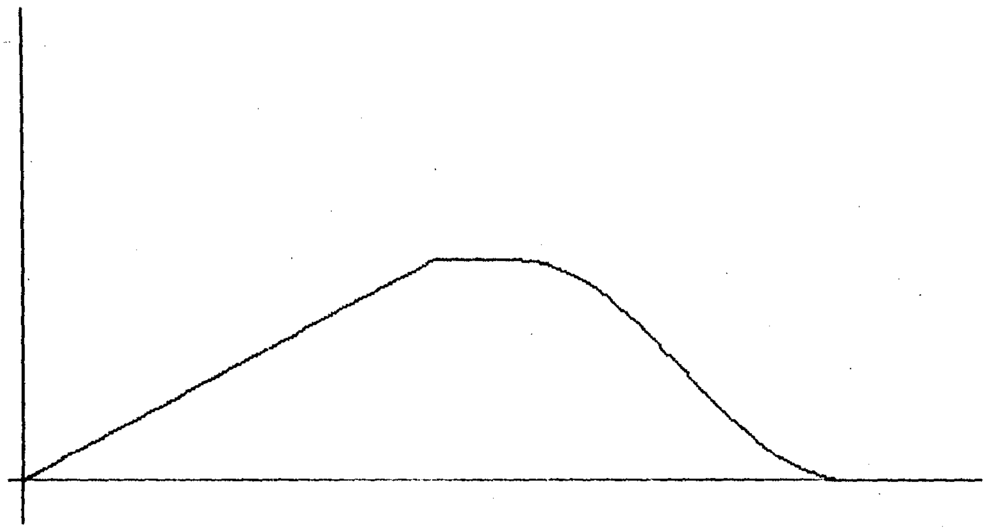
DISPLACEMENT DIAGRAM.

OUTPUT TO QUATION 3: PLOT 2.



CAM PROFILE DIAGRAM.

OUTPUT TO QUATION 4: PLOT 1.



DISPLACEMENT DIAGRAM.

OUTPUT TO QUATION 4: PLOT 2.

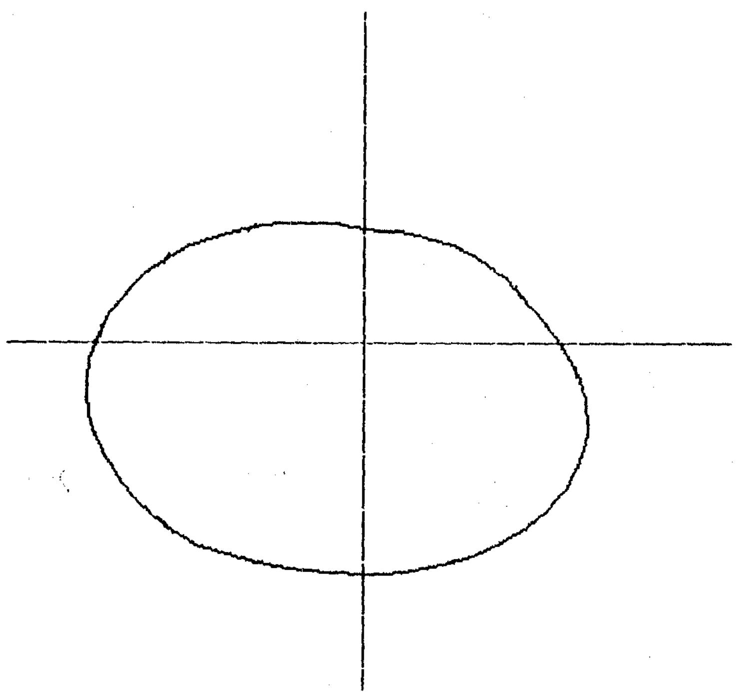


PLATE CAM DIAGRAM.