A CONTROL TECHNOLOGY OF INTEGRATED SYSTEM OF ENGINEERING SUPPORTED BY SOFTWARE ENGINEERING ENVIRONMEMTS

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Abstract

Having advanced developments of the aircraft design technology, the effects of the interaction, interconnection, interference of multidisciplinary synthesis in the aircraft design has become more important. The successful synthesis of the applications of multiple new technologies is the key of designing a new aircraft. The integration and the control technology of a great number of aircraft design software are the improtant tools in the competition of the aircraft markets.

The CIEM (Computer Integrated Engineering and Manufacturing) system is a integrated system for applying to aircraft design at multiple levels.

This paper describes the details of the principle and operation methods for integrating of engineering application programs. At the same time a executive control technology of integrated system of engineering supported by software engineering environments and a construction schema of engineering design object is introduced.

Introduction

The aircraft design is going to a more sophisticated synthesis design procedure due to the development of advanced technologies. The synthesis designs are not only to consider of the inferences to flight performance and charactersistics of aerodynamic configration, but also to use optimization techniques for sizing complex structures to harmonize elastic effects of structures to aerodynamic, flight cortrol, agility and maneuvre of aircraft, at the same time to consider of the effects of stealth technique to aerodynamics, power plant, structure weight of aircraft. These interaction inferences that some times even interferes each other more make aircraft design to become a very complex procedure. This is beyong to only use design experiences. In order to make a correct and accurate decision, and to reduce the design period and cost, almost every big aircraft company in the world has invested a great of scientists and money to research high performce, reliable and flexible design system.

In general these kinds of design systems are very complex and huge, include various static and dynamic behavior constraints of aerodynamic, structure, strength, systems, electronics,fire control, economic risk and software control that are supported by many support softwares and become very activity,under controled by executive software. All of these integrated application programs can take many different kinds of actors in different user's design flows for different designning objects.

The advantages of a integrated design systems are greatly to improve the design quality, and reduce the design period, to snythesis multiple disciplinaries that were used to run as a single mission tool in the conventional design to approach a optimization design, and to prevent failure and lose better design by experience, and to extract maximum benefits.

Another benifities of a integrated design system are to reduce labour power and labour faults, to increase design reliability, to speed design because of using a great number of automatic data transfer, transform and shared data and information. It makes a possibility for designing an aircraft that spent several months or years before that can be completed in several days or hours at a continuous computational design procedure. Especially for selecting of various design configrations this is more improtant.

Structure of A Integrated System

According to the features of aircraft design, a model of integrated system is shown as fig. 1 :

Principle and Major Functions

The software environment and system resources that the executive control software depended on are as follows:

A CIEM system consists of 3 parts:

(1) Integrated environment of support softwares (IESS).

(2) A set integrated application programs (SIAP).

(3) A Multiple function executive system (MFES).

B The integrated environment of supported softwares consists of 3 parts:

(1) A data base and a data file management system and corresponding information management system.

(2) A multiple function graphic display and creation system.

(3) A multiple function docmentation edition system.

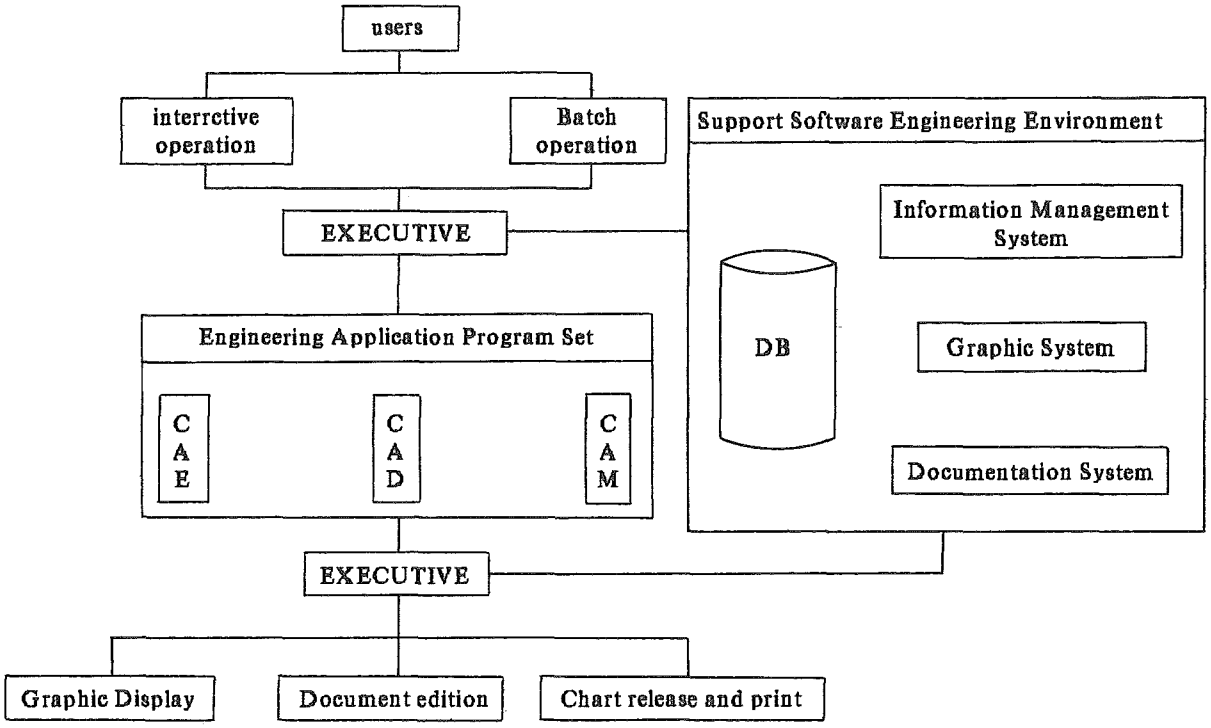


Figure 1.

C The resource of CIEM System is a growing resource. It is a developed and used applicational source by users except the integrated support–software engineering environment that the system depends on, generally there are 4 parts as follows:

(1) A set of integrated application softwares, it is called a software resource (SR).

(2) Three groups of data and information that are deposited in the data base and the data file management system and the private data management part. Total of them is called data resource (DR).

(3) A group of fixed working flows that are designed for completing some design objects, and they are often used in aircraft design. It is called fixed flow resource(FFR).

(4) Using FFR, DR, SR resources and the executive software of CIEM system, users can create user's applicational flows for user's engineering objects. After approved by authorized orgnizations, they become user's flow resource (UFR).

All of 4 resources mentioned above are opened to users classifily. They are the foundmental bases of executive software of the CIEM System.

Major Functions of Executive Control

1. The major objects of the CIEM Design System are as follows:

(1) To control flows of the fixed progrom flows and the user's option program flows.

(2) To control data flows of the program flows.

(3) In the program flows, to accomplish data transfer, data deposite and release, data transform of the integrated support software environment.

(4) to Complete processes of data, include of input, output, deposite, display, management,transfer,transform and release of data and information.

(5) A friendly user's interface.

2. The major tasks of the executive control software are as follows in order to achieve the major objects that the CIEM has:

(1) To establish connectional relations between engineering application programs and the data base and file management system (Archive) and the private data management system.

(2) To establish relations among engineering application programs.

(3) To establish connection relations among softwares of the integrated support software environment, in another meaning it is to integrate support softwares.

(4) To establish connection relations between engineering application programs and graphic and documentation softwares.

It is obviously that the executive control system needs a fundamental environment that is as follows:

(1) An universal data format (neuter file) in the CIEM system, It is called U.F.

(2) A integrated environment of data base, file management system, graphic and documentation system.

(3) A group of engineering application programs.

Standard Running Element of Engineering Application Programs

In order to make integrational works easily and simply, A kind of standard integrational model is provided by the CIEM system.

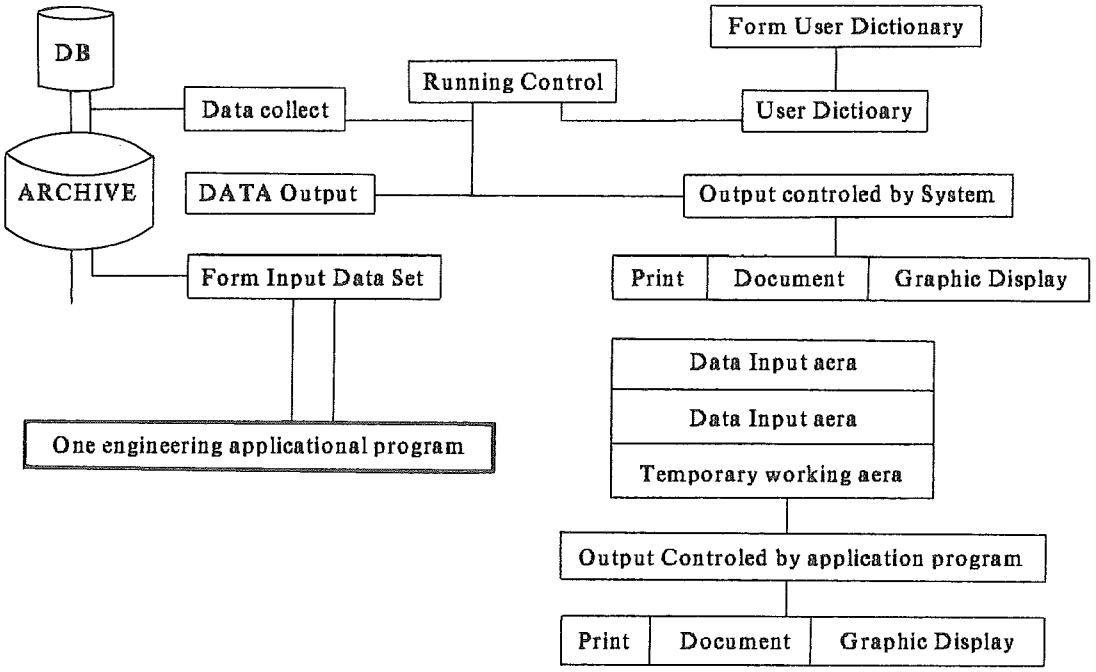


Figure 2.

Fig. 2. shows the basic works of integrating one engineerinng application program for running in the CIEM system.

Basic Model and Exteral Interface of Executive Control System

The CIEM system is a multiple users system, users share one support software environment. So the basic executive model of multiple user's program flow and the fixed program flow of the CIEM system is shown as follow:

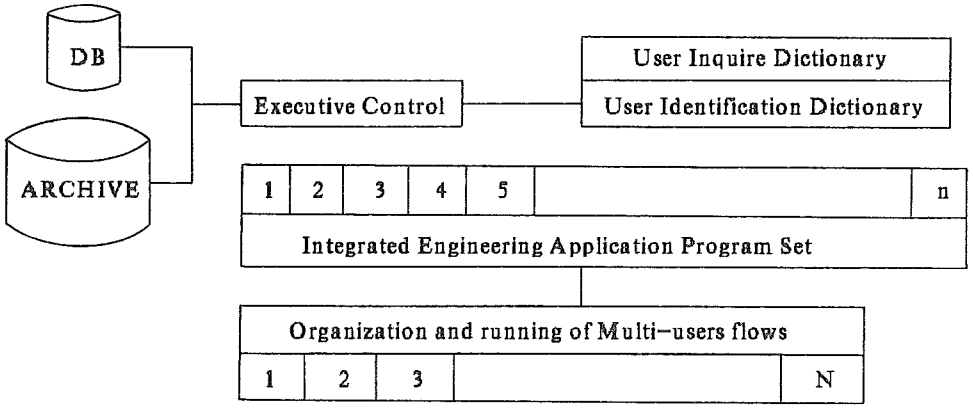


Figure 3.

The external interface between users and the CIEM system is operated through the executive system, users only have relations with input, output, and user's monitor or some similar interfaces of the executive system of CIEM. Figure 4. shows a relation of them.

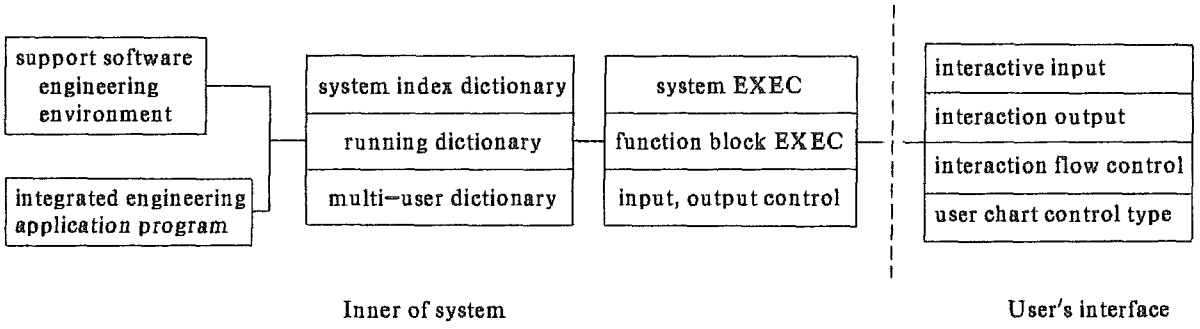


Figure 4.

The Integration of Engineering Application Programs

1. Integrated Model

Engineering application programs can be integrated without special effort, it is a standard procedure and CIEM operaters need not to understand engineering application programs, the interface is also standard. In flight vehicle design, there are data relations among engineering application programs, it is a network structure data. The shared data condition determines the integrated model of the CIEM system.

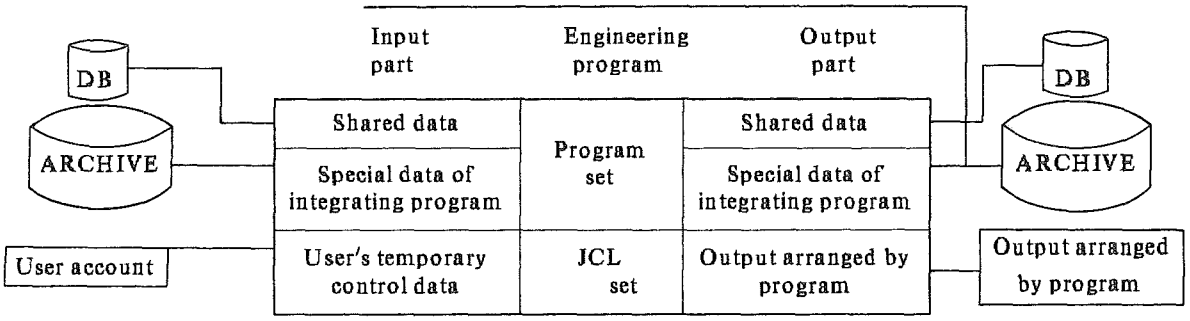


Figure 5.

(1) The standard interfaces of the shared data are written as the neuter files (U.F), the CIEM system offers the standard interfaces.

(2) The special user's data can be also written in U.F format, but it must be stored in the ARCHIVE in U.F format,. Because it is possible that special user's data can be transfer to shared data with growing of SR source.

(3) The temporary user's data and information are inputed on user's account under MVS of computer's operation system.

(4) All of the data written in U.F format are supported by integrated support software engineering environment of the CIEM system, they can be graphical displayed and documentional released.

(5) In the running , data output or data input arranged by a engineering program are operated by this program.

(6) The group of JCL (Job Control Language) is a total of multiple subflow's JCL of a engineering program.

(7) After offerd data format of user's format data, they also can get support from intgrated support software environment of the CIEM system through standard interface.

2. An Integration Procedure of An Engineering Program

An Integration procedure is as follows:

(1) There are two kinds of engineering application programs in the CIEM system, for different kinds of programs the CIEM system uses different methods to reproduce the input and output interfaces of programs by the U.F format.

a. To write input and output data interfaces for the programs that were introduced from out of the CIEM system and no source language programs from outside of the CIEM system.

b. For programs written by source languages, outputs and inputs of programs can be reproduced to fit with U.F format or make input and output data interfaces.

(2) To offer two lists of input and output files of the program.

(3) To offer two lists of input and output files of each subflow of multiple subflows of the every program.

(4) To offer a set of running JCL of every program.

(5) to offer one or two test calculation models for testing the accuracy of integration.

Forming system recources

Describe of The Configuration of CIEM

The system resources are the fundations of system operation, Figure 6. shows a chart of the system resources.

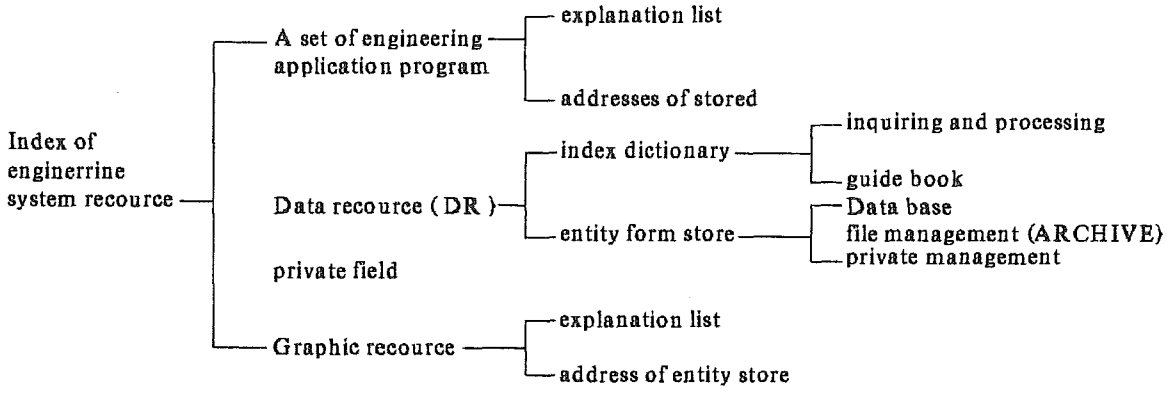


Figure 6.

At the same time the code system of all of programs, information, documents, data and grapfics are established.

The Organization of Engineering Flows

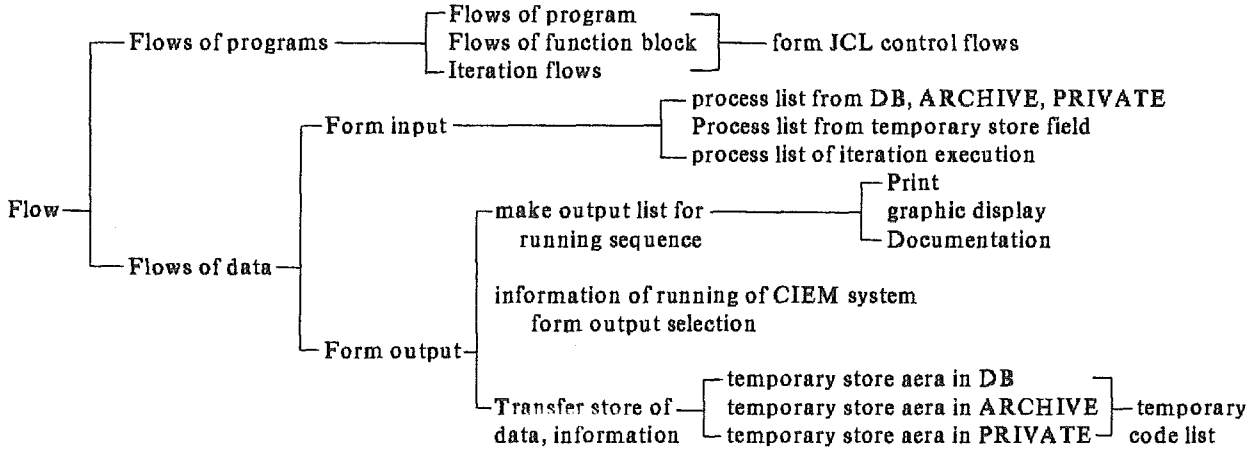
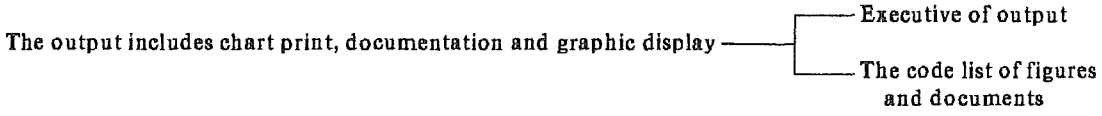


Figure 7.

Output Executing



User's Interface and Monitor Design

User's interface includes user's interactive operation, batch operation, system resources inquirement and user's class preparational operation.

The Safety Management of System

In order to suit different users, system reliable and system safety, the CIEM system uses a key–lock safety method.

Major Techniques

Technique of System Hardwares Resources

(1) Dynamic overlay

The main technique of the hardware resources of the CIEM system includes the management of space management of internal memory and hard disc memory. the method is a technique of controling of disc and internal memory. Figure 8. shows a view of dynamic overlay technique.

(2) Dynamic Overlay Technique

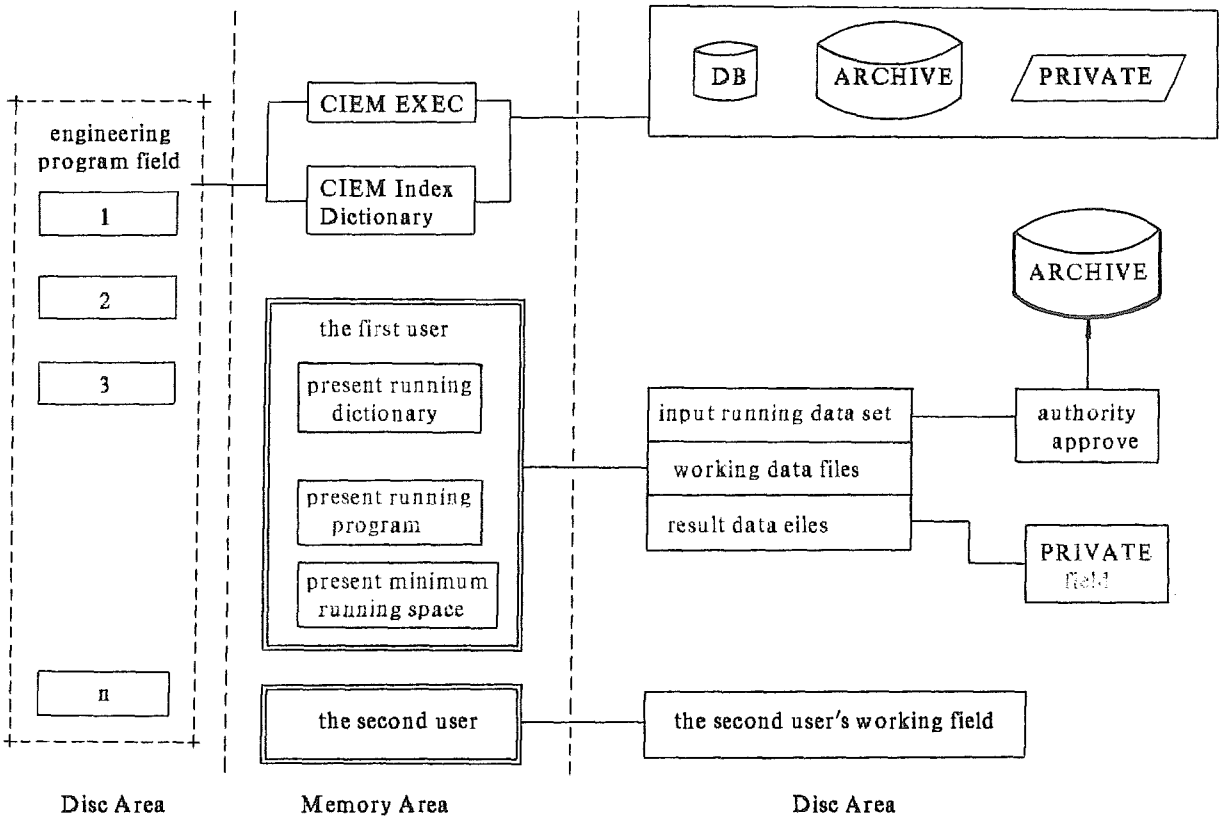


Figure 8.

(2) Dynamic control technique

The dynamic technique are consisted of two parts, first is to define space of internal memory and disc of the programs that is written by source language , then to compile progarms that their spaces have defined as load programs, and the same time to define the spaces of JCL set of the programs, then to run them. Second is to define the space control of program flows.

A. A dynamic compile of programs

For the programs and function blocks that are source language programs can be made dynamic space definitions of internal memory and hard disc for running the programs. The actions of definition are stated as follows:

a. As the regulations of the CIEM system to offer necessary information for defining the running internal memory and hard disc space that the program needs presently.

b. As the regulations of the CIEM system to offer necessary information for defining the running spaces of the corresponding JCL set.

B. The system running dynamic control of internal memory and hard disc

In spite of any running flow, it can be seen from Figure 7. that in the internal and external memory used as system temporary working field there is only one program is running presently. The hard source that this program occupies is also defined according to the user's calculated model or the defined spaces that was defined fixedly by the program at that time. So with the flowing of the program flow, the occupied space of internal and external memory of the flow is changing dynamically, then the object of dynamic control is achieved.

The Technique of Flow Control

The technique of flow control can be divided into four parts according to different functions:

A. Dictionary technique
B. Data collection
C. Running control
D. Output control

(1) Dictionary technique

a. To form Internal Inquiry Dictionary (IID) of the system

b. To complete the User's Dictionary (UD), Multiple User Dictionary (MDD) and Data File Dictionary (DFD) according to the flow information, input and output information that are offered by users.

c. To offer the User's Inquiry Resource (UIR).

(2) Data collection

The data collection of running control is the data and information input procedure that is to collect data and information from data file management system (ARCHIVE) and data base for running programs according to User's Dictionary (UD) and Data Resource (DR), then to form present running files according to data file input channels of the programs, at the same time the executive control software defines the necessary spaces of present program's JCL set.

(3) Running control

a. To input data and information using interaction at user's monitor or other dialogues.

b. To organize running procedure of the user's requirements and to complete the running objects.

c. To organize data flow transfer correctly

d. To output running results according to user's requirements in the running procedure and after the running.

(4) Output control

The output control of system is available in the whole running procedure and it includes the running procedure information and data output that is arranged by system. The output items that are arranged by programs and are selected by users.

Iterated Pocedure Dsign Technique

There are many iterated design procedures in engineering design. So there are many iterated running procedures that are consisted of one or several programs repeatedly used in the user's flows. For controlling iterated runnning the follows are needed:

(1) To get information of the number of iterated procedures and their sequence.

(2) To get the content of the iterated procedures, include names of programs and sequence of programs.

(3) To organize the flow of the iterated procedures, and to organize the program flow of every iterated procedure.

(4) To organize the data flow of the program flows.

(5) To insert the iterated procedures into the other program flows to form general flow, include program flow and data flow.

For engineering applicational objects, the task of running engineering programs iterately is to get a iterated or a convergence result that is to satisfy some targets. The executive control software needs a standard process procedure.

According to a defined iterational number to control running of program flow is a simple technique. For controlling to stop running a program flow according to some user's covergence targets is a quite complex procedure. Because the user's convergence targets can be one or several targets, and it maybe to reach convergence at the same time.

In this case, users have to offer two kinds of convergence information are shown as follow :

sequence of iteration	type number of iteration	amount iteration	convergence value					
			1	2	3	4		N
1	1	5						
2	2		0.08	0.2	0.1			
3	1	10						

Here:

Iteration sequence – the sequence number of iterated procedure.

Type number of iterated procedure –

1 represents iterated unmber ordered by user.

2 represents a constraint of convergence

The value of a constraint of convergence – in the above table 0.1 represents a relative allowance for predicating convergence.

Model of Information Control

Basic Process Model

U.F format data block is the basic process element used to transfer and transform data and information in the CIEM system, So U.F format is a basic relation for connecting engineering application programs and the softwares in the support software environment. In the CIEM system , the U.F data block is defined as follows:

(1) Uuique – Every data block that store in DB or ARCHIVE is coded and it is different from another.

(2) integrity – Every data block is a complete U.F block, so every data code represents a user's model completely.

(3) Independence – Every data block of a user's model is one independent part.

(4) Consistency – Every data block can be consisted a user's model with other datablock, and every data block can be a user's model.

Process Type of Coding

The code of data block that the executive control system asked is consisted of two parts. The front part describes the content information of user's model,the rear part is the inner code in the inner of the CIEM system of this data block. The front part includes of the type, creation, conponent, part, working condition, attribute, issue and security code. The rear part is a defined inner code by the information management system, it is a 8 digits code, and it offers necessary information for sorting the data block in the DB and ARCHIVE.

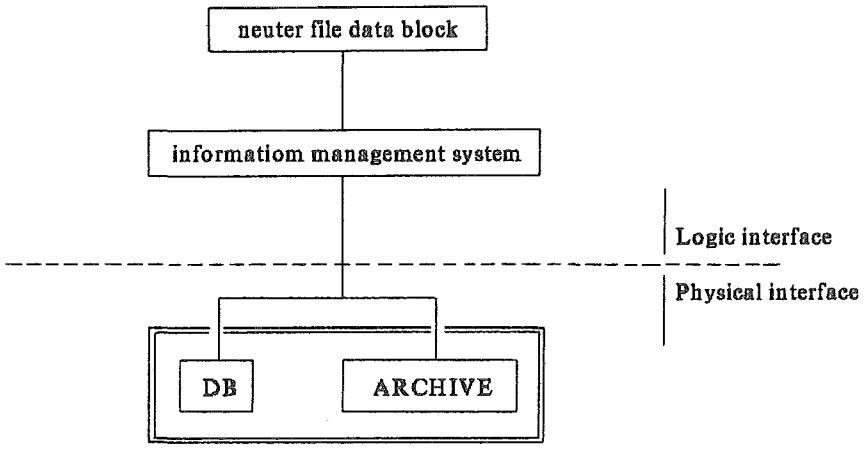
The functions of this code is as follows:

(1) To define the interface between users and system.

(2) To set a relation between users and system resource.

(3) To simplify data and information transfer and transform in the inner of the system, and speed inquiring procedure.

(4) To make a base for standard information management system.



Figue 9.

Formming Input Files of Engineering Application Program

In general the input and output files of engineering application program consist of several data blocks, and suited to the regulations of the CIEM system. the system inquiry dictionary (IID) that is formed using these integrated informatiom can offer sufficent information to model data file by the system executive control software.

Information Management System

The executive control system of the CIEM system controls all of input and output of engineering application programs, so the information management system is asked to manage all of information that is related to input and output.

Input includes:

(1) The shared data transfered by DB.

(2) The data transfered by ARCHIVE.

(3) The data transfered by users account under the MVS

(4) The data transfered by graphic system.

Output includes:

(1) The print self-arrenged by engineering application program.

(2) The print arrenged by system.

(3) The graphic display arrenged by system.

(4) The documents released by system.

(5) The data and information transfered to DB or ARCHIVE arrenged by system.

Obviously, except output that is arrenged by engineering application program, all of output are controled by the executive control software. So all of data and figures in the CIEM system must be coded.

Subexecutive Control and Function Block

There are two types of control in the executive control software. After having finished forming program flow and data flow, using function of flow control to running programs is called system control (SCC). Under the SCC the ability of using function blocks and some programs to form a complete program is called subexecutive control.

Different from engineering programs, function block can be an uncomplete running program, so the executive control of it is little different from system control (SCC).

The definition of Function Block

(1) definition

A program or a set of programs or modules that satisfy follows conditions are function blocks:

a. Having funtions to complete some user's objects.

b. having complete input and output interfaces and running connections.

c. having standard input and output U.F format.

d. written by high-level language.

(2) Creator of program

a. The creator of program can be made by special languages, in the CIEM system, in order to reduce the pressure of users and be more automatic, a user's list type and subexecutive control method are used. The functions of the creator of program are to receive user's information list, to use function block to form language programs and to compile and load them.

b. In order to use creator of program, the data file transfer among function blocks and programs is a basic condition, the spaces that come from user's model is offered as an information list before to use the executive control software of the CIEM system, then subexecutive control is used to form JCL set of the program. Obviously, there is a standard format of JCL in the CIEM system.

(3) Integrated function block has U.F format input and output interfaces.

(4) The integration procedure of function block is similar to the method that is used for program.

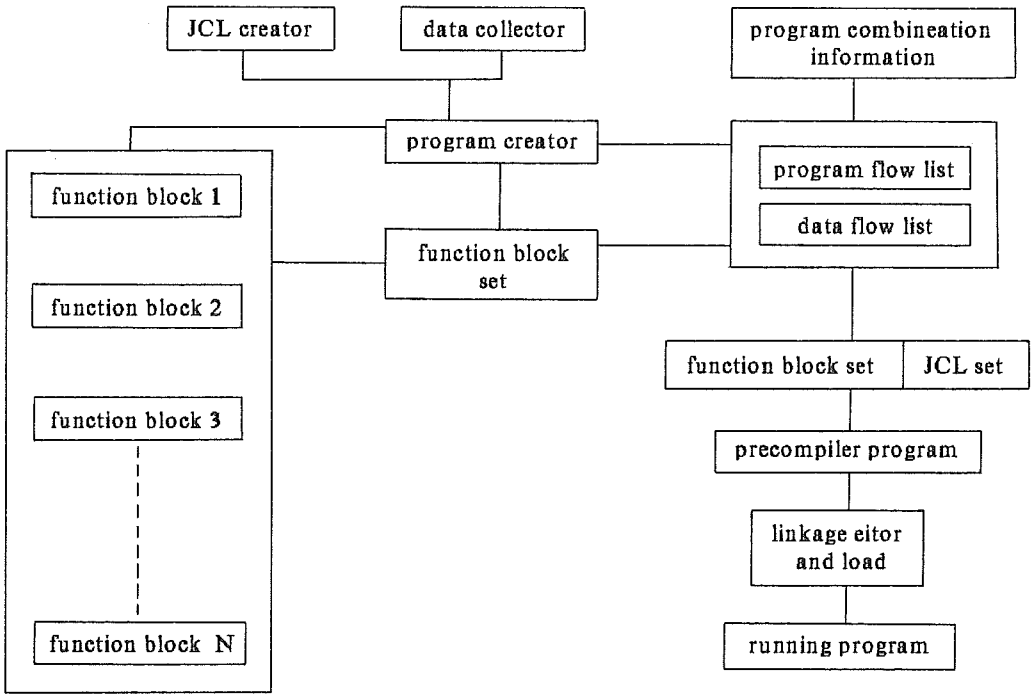


Figure 10.

Security and User's Authority

Security is a users interface, it includes system software and system resources. Here describes system resources security.

(1) Security of system resources

The system resources are divided into 3 classes: opening, secret and top secret. Every file in ARCHIVE is given a security identification, every data block in the DB is given a security identification according to user's orders. A numerical code system is used to describe a U.F data block or a data file.

(2) User's authority

The principle of Key –Lock is used in the CIEM system. According to a class that the class of resources a user has in the CIEM system defines user's authority class. the method is a random number method that is relately simple and difficult to decode destructively.

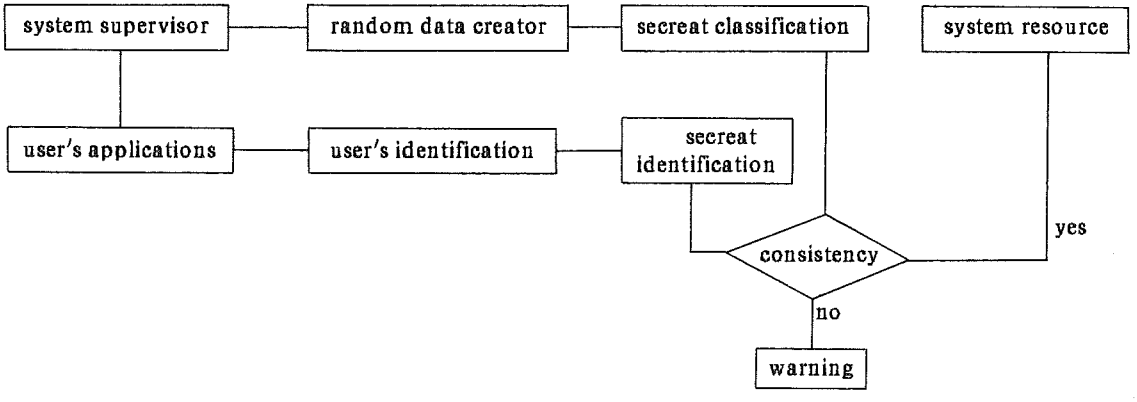


Figure 11.

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