Chapter 3

Computer Aided Political System Simulation (CAPSSIM)

3- Computer Aided Political System Simulation (CAPSSIM)

3-1- Prologue- Simulation is a technique of building an abstract, logical model of a system, which describes the internal behavior of its components and their interactions, including stochastic variability. It enables the behavior of the system as a whole to be predicted so that we many gain information about the system, or train personnel in its operation, without disrupting the real system, because experimenting with the real system is impossible or uneconomic.

A political model is the explicit interpretation of one's understanding of the political situation, or merely one's ideas about that situation. It can be expressed in mathematics, symbols or words, but is essentially a description of entities and the relationship between them. It may be prescriptive or illustrative, but above all, it must be useful.

For the purpose of modeling political-enterprise processes within them, the technique used in digital discrete-event simulation. This approach models systems by chaining between discrete states at definite time points.

A strategy for the use of simulation modeling methods for the planning of advanced political enterprising systems is purposed. It has been proven both for academic purposes and in the feasibility and planning stages of several real projects.

The overall objective of this strategy is to provide a cost effective approach, with the level of effort and detail of modeling at each stage of planning being geared to its particular needs.

The strategy as described, can be though of as a hierarchy of analysis, and requires a number of modeling tools to be used. The main emphasis is on the analysis of the flow of polit-fact within the system, rather than capacity planning. This approach is used to ensure that materials handling *is* efficient and so to maintain high processing unit utilization without the need for high work-in progress levels.

Simulation models can be employed at four levels:

- As explanatory devices to define a system or problem;
- As analysis to determine critical elements, components and issues;
- As design assessors to synthesize and evaluate proposed solution;
- As predictors to forecast aid in planning future developments.

This chapter describes briefly the conceptual framework used to simulate of political enterprising systems and processes.

3.2- Functions of Computer Aided Political-system SIMulation (CAPSSIM):

- Model of whole political-enterprise system and processes
- Model of traffic, time modeling
- Definition the most control point of integrated enterprise
- Part introduction
- Selection of parts from queue
- Selection of next operation
- Station selecting
- Transporter selection
- Transporter scheduling
- Programming the simulation processes.

3.3- Basic Definitions in CAPSSIM:

System - A set or assemblage of things connected, associated, or interdependent, so as to form a complex unity; a whole composed of parts in orderly arrangement according to some scheme or plan.

Political Model - A simplified or idealized description of a political system, -situation, or -process, often in mathematical terms, devised to facilitate calculations and predictions.

A model is a representation of a system of objects or ideas *in* a form other than the system itself. Simulation is an operations research-based technique used in the definition, development, and analysis of a model.

A political simulation model is a simplified representation of political real life which allows the understanding and solution of a problem to be achieved by a trial and error approach.

Simulate - To assume falsely the appearance or signs of (anything); to feign, pretend, counterfeit, imitate; to profess or suggest (anything) falsely.

Political Simulation - The technique of limiting the behavior of some political-situation or -system (economic, military, political, etc.) by means of an analogous situation, model or apparatus, either to gain information more conveniently or to train personnel.

Simulator - An apparatus for reproducing the behavior of some situation or system.

Intuitive Simulation - The majority of problems with which we are confronted *in* our everyday life require a decision within seconds or minutes. In the time available we balance in our minds eye the factors involved and the implications of alternative courses of action. We make a decision based on our past experience and a quick review of the alternatives. The approach does not require a great deal of time, and is justified when a good answer now is better than the best possible answer after lengthy deliberation. Most line managers live in an environment where they have to give quick answers to questions and they are judged on their ability to make good intuitive decisions. These tend to be the day-to-day operational decisions falling within the range of past experience and all concerned hope that the penalty for making a mistake is not too painful.

Analytical Simulation - Some problem are less restricted by time. These tend to be strategic problems where mistakes are potentially expensive. The time available must be used as effectively as possible to improve confidence that the correct decision has been made.

The analytical approach is used when the behavior of the factors involved and the relationships between them can be fully described. The problem is defined in mathematical terms-such as simultaneous equations-which are then solved to give the optimum answer. This approach normally requires mathematicians, programmers and a computer to perform the analysis.

Numerical Simulation - In most cases the lack of time is not our greatest difficulty, but the lack of suitable information, understanding of the problem and the capacity to describe *it in* a structured way. Most people have difficulty in describing their problems formally and they distrust specialists who claim to be able to generate the optimum answer by using a computer. In the numerical approach we experiment with alternatives and, with the better understanding this gives, 'home in' on an answer.

Animation - The use of computer graphics to dynamical l y display simulation entities and their activities is defined as animation.

3.4- Political-System Simulation, Models - Polit-system simulation techniques are commonly required where there are limited facilities to handle traffic, political-facts, communication, or political-information transactions. Simulation is a tool for the analysis of complex oriented systems. It is the tool to be used when other tools cannot provide the insight required to predict system performance.

A political system simulation is a representation of a political process or political environment. It is done by setting up a model of the real political system. Computers are often used for simulation for several reasons. Computers allow a wide variety of conditions to be tested quickly using mathematical techniques. Simulation permits the accumulation of data to predict the behavior of the real process under a variety of situations.

Simulation the facility or process of interest is usually called a system, and in order to study it scientifically we often have to make a set of assumptions about how it works. These assumptions, which usually take the form of mathematical or logical relationship, constitute a model that is used to try to gain some understanding of how the corresponding system behaves.

If the relationship that compose the model are simple enough, it may be possible to use mathematical methods (such as algebra, calculus, or probability theory) to obtain exact information on questions of interest; this is called an analytic solution. However, most real-world systems are too complex to allow realistic models to be evaluated analytically, and these model must be studied by means of simulation. In a simulation we use a computer to evaluate a model numerically, and data are gathered in order to estimate the desired true characteristics of the model.

Political system simulations mybe classified according to:

- The kind of computer used (analog, digital, hybrid)
- The name of the stimulant (social, political, economic system)
- The temporal relation of events in the stimulant (faster than-real-time, real-time, slower-than-real-time, with real-time being clock or stimulant time).

Simulation has a number of distinct functions in the design of complex systems. Among the advantages gained in using political-system simulation are:

- The problem definition becomes clearer,
- Design uncertainties are reduced,
- Problem definition is more complete, and the influences of data uncertainties are lessened,
- A dynamic representation of the political system is produced.

The following factors help to reduce the effort a useful simulation demands:

- Use a simulation language. It will help in problem definition. The total cost for the simulation will be significantly less. The results with be available sooner, and there with be considerably less effort required to change the simulation to reflect the progress in system synthesis.
- Select those areas of greatest sensitivity for investigation. The results from early versions of the model point out the areas that require concentration and greater detail.
- Anticipate the methods of model validation. Select what is considered appropriate for the system. Beware of the Limitations inherent problem definition, input data, and representational faithfulness.

3.4.1- Discrete Event simulation - In a discrete event simulation, the time sequence of political real-world events is reproduced by the simulation; the state of the simulated system changes only at the discrete times when events occur. After the state update has been computed, the simulation clock is advanced to the time of the next event.

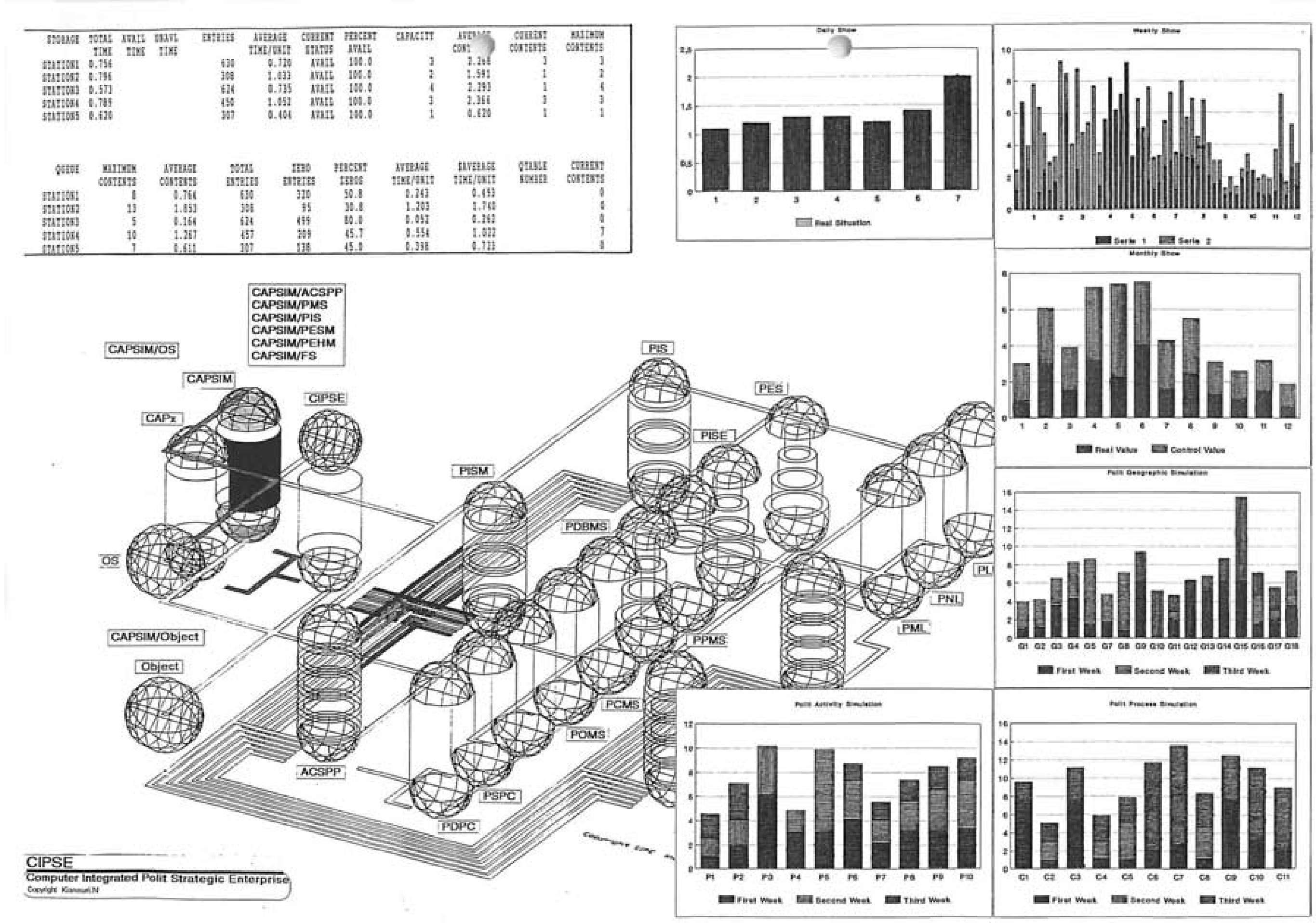
3.4.2- Monte Carlo Simulation - The name of Monte Carlo invokes of gambling, roulette, and chance. Now Monte Carlo Simulation is defined as a scheme employing random numbers that is used for solving certain stochastic or deterministic problems where the passage of time plays no role. The last part of this definition (i.e., passage of time) is what distinguishes Monte Carlo from discrete event simulation. In discrete event models time plays a significant role.

3.4.3- Continuous Simulation- Continuous simulation is concerned with modeling a set of equations that represent a system over time. This system may consist of algebra, differential or difference equations set up to change continuously with time. Continuous simulation is sometimes used in conjunction with computer aided drafting (CAD) system.

3.5- political-Enterprise Simulation - Enterprising system, involves complex interactions whose effects is hard to predict. Simulation is a highly appropriate method of evaluating enterprise designs to ensure maximum efficiency.

Conceptually simulation of a enterprising system is similar to entering information on a Gantt chart, in a manner familiar to all solution controllers.

At its most basic, simulation involves recording everything that goes in the system, or rather our model of the system, and making decisions whenever they are necessary.



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STORAGE  TOTAL AVAIL UNAVL  ENTRIES  AVERAGE   CURRENT PERCENT  CAPACITY  AVERAGE  CURRENT  MAXIMUM
         TIME  TIME  TIME            TIME/UNIT STATUS  AVAIL              CONT.    CONTENTS CONTENTS
STATION1 0.756                  630    0.720   AVAIL   100.0           3   2.368        3        3
STATION2 0.796                  308    1.033   AVAIL   100.0           2   1.591        1        2
STATION3 0.573                  624    0.735   AVAIL   100.0           4   2.293        1        4
STATION4 0.789                  450    1.052   AVAIL   100.0           3   2.366        3        3
STATION5 0.620                  307    0.404   AVAIL   100.0           1   0.620        1        1


 QUEUE    MAXIMUM   AVERAGE    TOTAL    ZERO   PERCENT   AVERAGE   $AVERAGE  QTABLE  CURRENT
          CONTENTS  CONTENTS   ENTRIES  ENTRIES ZEROS    TIME/UNIT TIME/UNIT NUMBER  CONTENTS
STATION1       8     0.764      630      320    50.8     0.243     0.493              0
STATION2      13     1.853      308       95    30.8     1.203     1.740              0
STATION3       5     0.164      624      499    80.0     0.052     0.262              0
STATION4      10     1.287      457      209    45.7     0.554     1.022              7
STATION5       7     0.611      307      138    45.0     0.398     0.723              0
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FIG.3.1. SHOWS A COMPUTER INTEGRATION OF SIMULATION STATION AND INTERFACES BETWEEN CIPSE STATIONS. THE GRAPHIC CONSIST OF:

1 - OUTPUT OF SIMULATION PROGRAM.

2 - OTPUT OF SIMULATION FACTORS IN GRAPHIC FORM.

3 - CAPSSIM STATION AND INTERFACES.

An enterprising system (a political center for example) is composed of computer and other technologies, political solution, personnel, work-in-progress inventory, political data-handling equipment, and so on. Computers and other equipment are often grouped in **workstations**. Work- in progress inventory typically moves from workstations to workstations. At a workstation, **an operation** (an elemental step in the enterprising process) is performed on a lot. The sequence of operations is determined by the technology of the enterprising process. If each operation can be performed at only one workstations, the operation sequence determines the route (the sequence of workstations visits) a lot must follow. Events that cause changes in the state of the components of the enterprising system include the arrival of a lot at a workstations, the beginning (and completion) of an operation on a lot, failure or repair of a machine, and so forth. Some events are exogenous, while others are the result of resource allocation decisions such as the beginning of an operation or the repair of a machine.

3.6- Mathematical Modeling - Simulation, and specially computer simulation, are widely-used terms for a large class of mathematical modeling techniques. Mathematical model is a mathematical representation of a system, process, device, or concept. Mathematical modeling is a recognized and' valuable adjunct, and usually a precursor, of computer simulation. Mathematical simulation use a model of mathematical equations in which computing elements are employed to represent all of the subsystems.

All forms of mathematical modeling, including simulation, follow the classic 'scientific method' of Hypothesis - Experiment Analysis - Deduction. This method is based upon the building of a 'system model', which is used as the basis for caring out of experiments. Simulation is the only currently effective method for analysis of stochastic problems, where random effects prevent single, simple, analytical solutions being derived.

Simulation can be distinguished from almost all other mathematical modeling methods in that it does not provide optimum results, although it is frequently assumed that it can. Accordingly, the best result that can be obtained is the best one considered.

Mathematical methods are a preferred way of approaching any problem, since they are deterministic and predictable. However, these factors are mitigated by the level of assumptions need in order to fit a real situation into a model. Although complete solutions have been developed for simple cells with limited numbers of processing and handling units, the modeling of larger systems requires the use of queuing theory.

Queuing-theory-based models analyze flow within a system. This analysis is undertaken by using queuing theory to build up networks and so provide a quasi-dynamic view of flow Statistical. These models are characterized by broad assumptions and limited input data.

3.6.1- Deterministic and stochastic Processes - A process is defined as deterministic if for every value of the input the output can be determined in some reproducible fashion.

A stochastic process is random. When sufficient observations have been made, it may be possible to find the Statistical distribution that governs the behavior of the system.

The system to be studied can be either deterministic or stochastic; the models of these systems can be either deterministic or stochastic.

3.6.2- Queuing Theory - Involves the mathematical study of queues, or waiting lines. The formation of waiting lines, of course, a common phenomenon that occurs whenever the current demand for a service exceeds the current capacity to provide that service. Decision regarding the amount of capacity to provide must be made frequently in policy.

The basic process assumed by most queuing models is the following. Political user requiring service is generated over time by an input source. These users enter the queuing system and join a queue. At certain times a member of the queue is selected for service by some rule known as the queue discipline (or service discipline). The required service is then performed for the political user by the service mechanism, after which the political user leaves the queuing system.

Input Source - One characteristic of the input source is its size. The size *is* the total number of users that might require service from time to time, i.e., the total number of distinct potential polit-users. This population from which arrivals come is referred to as the calling population. The size may be assumed to be either infinite or finite.

Queue - A queue is characterized by the maximum permissible number of political users that it can contain. Queues are called infinite or finite, according to whether this number is infinite or finite. The assumption of an infinite queue is the standard one for most queuing models, even for situations where of political user, because dealing with such an upper bound would be a complicating factor in the analysis. However, for queuing system where this upper bound is small enough that *it* actually would be reached with some frequency, it becomes necessary to assume a finite queue.

The Birth-and-Death Process - Most elementary queuing models assume that the inputs (arriving political user) and outputs (leaving political user) of the queuing system occur according to the birth-and-death process. This important process in probability theory has applications in various areas. However, in the context of queuing theory, the term birth refers to arrival of a new political-user *into* the queuing system, and death refers to the departure of a served political user.

The application of Queuing Theory - Queuing theory has enjoyed a prominent place among the modern analytical techniques of operation research. However, the emphasis thus far has been on developing a descriptive mathematical theory. Thus queuing theory is not directly concerned with achieving the goal of operations research: optimal decision making. Rather, it develops information on the behavior of queuing systems. This theory provides part of the information needed to conduct an operations research study attempting to find the best design for a queuing system.

3.7- GPSS/H Program of a Simple Queuing System - The same simple queuing system model can be developed using a simulation languages. Use of a language such as GPSS/H offers the simulation analyst many advantages. Included among these are:

- Construct to facilities the modeling of queuing systems.
- Built in Statistic gathering capability.
- Output report creation tools.
- Facilities for performance multiple repetitions.
- Reductions of debug and testing time.

By taking advantages of the tools provided by a simulation language, the analyst is able to produce a better model consisting of few lines of code.

GPSS/H employs a control language that uses a series of programming statements to initialize the model, set up experiment, produce output reports, and perform other maintenance functions. The control statements are typically executed first. They are used to start the actual block portion of the model.

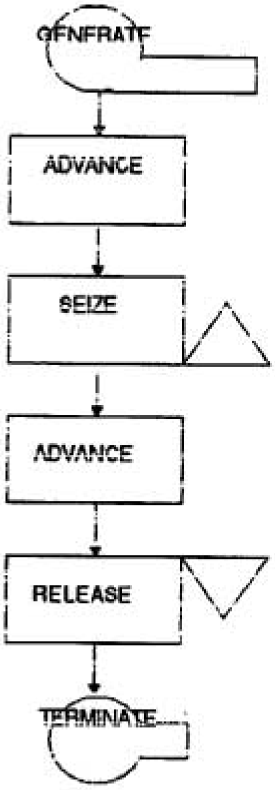


FIGURE IS A SIMPLE DEMONSTRATION OF GPSS BLOCS. GPSS BLOCS CAN BE REPRESENTED IN TERMS OF PICTORIAL DIAGRAMS SUCH AS THIS ONE.

3.7.1- Transactions in GPSS/B - Transactions are dynamic entities that travel through the networks of blocks in a simulation. Their meaning is defined by the simulation analyst while building the model. They are often created to represent an active such as an political inform in a integration simulation, or an political data in CIPSE stations.

Multiple transactions can exist in a GPSS/H model at any given time. They move through the block network as far as the current system state allows and stop either for a predetermined delay (ADVANCE block), a logical delay, or because a desired resource is currently unavailable. Since multiple transactions can be present in a model, parallel processes can be simulated.

Each transaction has associated with it a list of attributes called parameters that can be altered according to logic contained in the model. These parameters can be used to define unique characteristics of a particular transaction, thereby affecting its movement through the block networks.

Transactions have another attribute known as a priority level. The priority level can be set with a PRIORITY block or upon transactions creation with a GENERATE block. Priority level can range from 0 to 127. The higher the value, the close to the front of the current events chain the transaction will be placed. A transaction at the current events chain the transaction with be placed. A transaction at the head of the current events chain will be given the first opportunity to move through the network of blocs in each GPSS/H scan cycle.

Transactions are created by using either the GENERATE or SPLIT blocks. They are removed from the model with the TERMINATE or ASSEMBLE blocs.

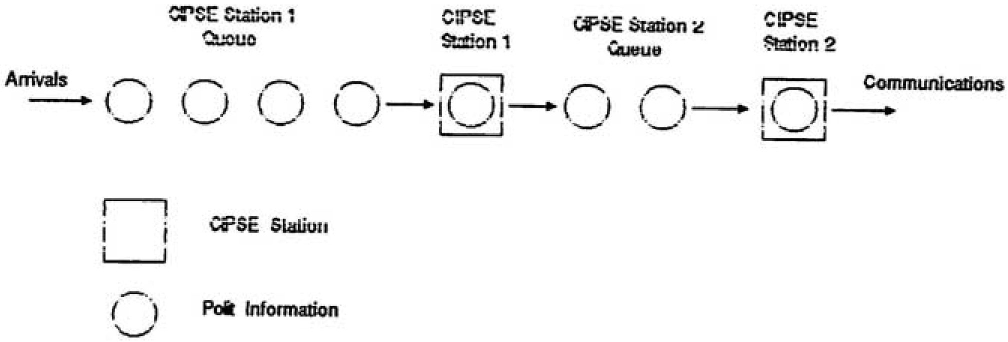
3.8- A SLAM Network of a simple Queuing System - As an introduction to SLAM network modeling, let us consider a simple queuing system in which items arrive, wait, are processed by a single resource, and then depart the system. Such a sequence of vents, activities, and decisions is referred to as a process. Entities flow through a process.

SLAM provides a framework for modeling the flow of entities through processes. The framework is a network structure consisting of specialized nodes and branches that are used to model resources, queue for resources, activities, and entity flow decisions. In short, a SLAM network model is a representation of a process and the flow of entities through the process.

To illustrate the basic network concepts and symbols of SLAM, we will construct a model of an integration process in the enterprising of political information. In this system, political information is communicated to CIPSE (Stations). Political enterprise stations examine and integrate each inform. After this integration, the inform leaves the enterprising stations. We can define following aspect of system:

- The arrival of inform to the CIPSE stations;
- The waiting of information in queue for integration; and
- The activity of integration of information.

THE PICTORIAL DIAGRAM OF INTEGRATION PROCESS IN CIPSE STATIONS IS SHOWN IN BELOW



We can combine the arrival, integration, and communication operation to obtain a complete network model of the one server, single queue process. This SLAM model is shown below. This network depicts the flow of an entity and all the potential processing steps associated with the entity. The first entity arrives to the system at the CREATE node at time TF. The next entity is scheduled to arrive TBC time units later, which would be at time TF+TBC. The first entity is routed to the service activity by the branch to the QUEUE node. The branch represents the activity of traveling to the server and is prescribed to be DT time units in duration. When the entity arrives at the QUEUE node, it will immediately be serviced if server A is idle. If this occurs, the entity flows from the QUEUE node to the TERMINATE node in ST time units. During this time, server A is busy. At last the terminate node can be used to specify that TC entity arrivals at the TERMINATE node are required to complete one run.

THE FIGURE OF NEXT PAGE IS A SIMPLE EXAMPLE OF SLAM NETWORK MODEL TFOR ARRIVAL, INTEGRATION, AND COMMUNICATION OF POLIT INFORMATIONS IN CIPSE STATION.

TF : IS THE TIME AT WHICH THE FIRST ENTITY IS TO CREATED AND SENT INTO NETWORK;

TBC : IS THE TIME BETWEEN CREATIONS OF ENTITIES;

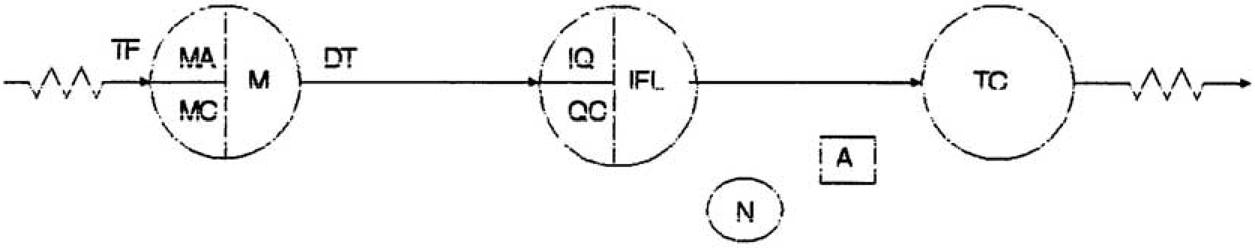
MA : IS THE ATTRIBUTE NUMBER IN WHICH THE CREATION OR MARK TIME IS TO BE MAINTAINED;

MC : IS THE MAXIMUM NUMBER OF ENTITIES THAT CAN BE CRAETED AT THIS NODE;

AND M : IS THE MAXIMUM NUMBER OF BRANCHES ALONG WHICH A CREATED ENTITY CAN BE ROUTED FROM THIS NODE.

DT : DELAY TIME TO TRAVEL TO QUEUE

IQ : INITAL NUMBER OF QUEUE
QC : MAXIMUM NUMBER IN QUEUE
IFL : QUEUE NODE INDICATOR
N : NUMBER OF PARALLEL IDENTICAL SERVER
A : ACTIVITY NUMBER
ST : SERVICE TIME
TC : NUMBER OF ENTITIES TO TERMINATE A RUN



3.9- CAPSSIM interfaces with other CIPSE Stations:

3.9.1- CAPSSIM / ACSPP (Simulating of System of Political Process) Related with use of simulation in automation control system of political processes. A system consists of a set of parts organized functionally to form a connected whole. A subsystems is a component of the total which can be treated either as a part of the total system or as an independent system.

Political-system simulation is the technique of constructing and running a model of a political real system in order to study the behavior of that system, without disrupting the environment of the political real system.

In any simulation study subsystems may follow a well-known behavior pattern or lend themselves to direct mathematical analysis.

3.9.2- CAPSSIM / SCPP (Simulating of Statistical Control of Political Process) System to be simulated are generally composed of one or more elements that have uncertainly associated with them. Such systems evolve through time in a manner that is not completely predictable and are referred to as stochastic systems. The simulation of stochastic systems requires that the variability of the elements in the system be characterized using probability concepts. The outputs from a simulation model are also probabilistic, and therefore Statistical interpretations about them are usually required.

Statistical capacity planning is the technique of establishing the number of processing units required by using simple arithmetic based upon processing times and required volume throughput. Additional allowances are usually incorporated for breakdowns, setting-up, and so on.

Overall, this level of modeling gives the minimum number of processing units, by type, and provides some measure of the throughout times. Sensitively analysis can be performed, but no account is taken of congestion in the political facts handling system.

There are two basic forms of Statistical which can be observed:

1- Simple variables, such as the time in the system of an entity, these individual observations are usually summarized in mean and variance Statistical and/or presented as histograms. The term used to describe them varies from package, and include "observed data", "tally variables", "generated data".

2- Time-dependent variables, such as the number of jobs in a system. These may be stored in the form of histograms and summarized by their mean, variance or other Statistical. These methods of summarizing the data destroy the time base of the data. To preserve this, they can be collected as time series, either sampled at regular intervals, or as a set of pairs of values and time intervals since the last observation or change of value. The names used to describe them vary from package to package, and include "time-dependent", time series", "time-persistent" and "time-generated data".

Virtually all simulation packages provide a facility for computing these summaries Statistical.

3.9.3- CAPSSIM / PDCP (Simulating of Political Dynamic Control Process) the time is the most commonly used indexing attribute in the formalization of the dynamics of system simulation.

Dynamic modeling techniques are used when continuous change predominates. We can frequently describe the way the variables over time by mathematical equations.

A simulation model portrays the dynamic behavior of a system over time. A model is built to provide results that resemble the outputs from the real system.

System dynamics is a problem solving approach to complex problems which emphasizes the structural aspects of models of systems. State variables, called levels, are defined in difference equation from and may be nonlinear. Nonlinearities are also included in the model through the use of table functions, delays, and clipping operations. The DYNAMO programming language was developed to provide a language for analyzing Systems Dynamics models. DYNAMO uses a fixed step size, Euler-type integration algorithm to evaluate the level variables over time.

3.9.4- CAPSSIM / MPIS (Management factors for CAPSSIM) - Simulation management is a tool for the analysis of complex systems. It is the tool to be when other tools cannot provide the insight required to predict system performance. The following factors help to reduce the effort a useful simulation demands.

- Use a simulation language; It will help in problem definition.
- Limit your objectives; to model the complete system accurately will require more time and money than is available.
- Select those areas of greatest sensivity for investigation.
- Anticipate the methods of model validation. Select what is considered appropriate for the system.

3.9.5- CAPSSIM / PISE (System Engineering of CAPSSIM) - There are four stages in the construction of a simulation model. The process involved has been explained in detail elsewhere. Accordingly, this review will be brief. The stages are:

- Problem definition and data collection. This consists of the analysis to determine the scope the model, and to establish the assumptions to be made. The data need is then established and collected. This can cause major difficulties, especially where proposed systems are concerned. For example, realistic reliability Statistical for modern machine tools are notably difficult to obtain.

- The construction and refinement of the model. This is probably the easiest and most rapid part of the process. Major problems at stage are almost always caused by inadequate attention to problem definition and data collection.
- Verification and validation of the model. Verification is the process of checking to see that the model functionally meets its specification. Validation is the process of ensuring that the model does what is intended. This is usually achieved by comparing the results of several runs of the model with each other and with real data, where this is available. It is at this stage that any assumptions not previously considered often reveal themselves. The objectives of this stage are to generate confidence in the model and to assess its level of meeting reality.
- Model experimental ion and results analysis. This stage is often treated in s summary fashion. Variance reduction techniques should be employed to isolate the effects of various parameters.

Political Enterprise Job Scheduling - A CIPSE-job is a political consisting of a set of CIPSE workplaces operating independently. This set of workplaces may be divided into subgroups of workplaces which have the same characteristics. A job is a unit of output produced by a series of operations performed on workplaces in a specified sequence. This sequence is called the routing or the technical sequence of the CIPSE-job.

When scheduling jobs through the CIPSE, the objective is to ensure that the operations are done in the proper sequence, while meeting such criteria as minimizing late deliveries, maximizing utilities of equipment, or minimizing in-process inventories. There are two classes of CIPSE-job problem:

1- The Statistical case, in which all jobs are on hand at time zero.

2- The dynamic case, in which job arrivals vary with time.

Many scheduling rules have been suggested, including:

- **First in-first out (FIFO):** the CIPSE -job with the earliest arrival time in the queue is selected.
- **Highest priority:** each CIPSE-job is assigned a priority on arrival. The job with highest priority gets the workstations first.
- **Shortest processing time:** the job that requires minimum workplace time is chosen from the queue of waiting jobs.
- **Smallest remaining job slack:** the job that has minimum job slack is selected. The job slack, or remaining free time, is defined as the due date, minus the current time, or remaining free time, is defined as the due date, minus the current time, minus the sum of the remaining processing times for that job.
- **Earliest job due date:** the job with the earliest due date is chosen. This is similar to (4) above but does not include processing time in the scheduling rule.

3.9.6- CAPSSIM / PDBMS (Data Base Management for CAPSSIM) - Simulation needs data to work on, and that is usually in short supply unit 1 well on into an CIPSE project. The quality of available data may be a key factor in determining the level of detail and accuracy of the model. One of the important skills of a simulation expert is in knowing how to summaries the data to simplify the modeling process and to minimize the sensitivity of the results to errors in data estimate.

3.9.7- CAPSSIM / PPMS (Projecting a CAPSSIM) - The ideal leader is someone who can provide the project control, enthusiasm and technical guidance that will exploit the abilities of everyone concerned. It is unfortunate that many of the management training establishments around the world have failed not only to give adequate simulation training to their students, but have also neglected to provide basic training in project control.

A typical simulation project can be divided into a number of stages as follow:

- Problem definition;
- Project team selection and training;
- Model building and testing;
- Experimentation and modification;
- Presentation of recommendations;
- Implementation;
- Review of project.

Each project requires leadership, technical ability and good communications, which in turn lead to involvement and finally commitment.

3.9.8- CAPSSIM / PCMS (Simulation of political Communication Management System) - One of the most important skills that a simulation analyst can possess is the ability to communicate effectively. Communication is required throughout the entire modeling process.

The purpose of PCMS is to describe the use of simulation languages as a tool for analyzing the performance of teleprocessing system. To do this, the fundamental features of a real-time database/data-communication system with be considered. Such a system must control many messages arriving at random from remote terminals and must provide data management for each application (integrated data base).

In a teleprocessing system, the number of interactions among the systems elements can be very large, so that it is very difficult to determine the overall dynamic system performance of a complex installation. Simulation is one of the techniques that can be used to study the system operation.

3.9.9- CAPSSIM / PEOMS (Organization of a CAPSSIM) the simulation analyst is defined as the individual responsible for all aspects of modeling process. The ideal model builders are those who fully understand the details of the problem area and where to get the data; who are trained modelers; who are good friends of the management involved; who have a clear scientific questioning approach; and who are eagle to get the answers as quickly as possible. If we happen to be, 0] have available, such persons then we are lucky. More likely we have to bring together a number of people who can jointly satisfy some or all these requirements. They must be able to communicate their knowledge and will have to be led. In most cases one or more of the team, and the managers to whom they report, will require training and this must be assessed in estimating both project time and cost. The purpose of training is to:

- Create the model builders;
- Give managers an appreciation of simulation and the type of questions that simulation models can answer.

The training of the model builders can either be done be attending a formal training course, which take the participants step by step through the modeling discipline, or by 'on-the-job' training.

3.9.10- CAPSSIM / PIS (Intelligence Simulation) - The use of simulation methods in conjunction with decision analysis based on artificial intelligence is an area with almost limitless potential. This is more advanced than pure decision support, and is a longer-Term concept.

Although the fields of artificial intelligence (AI) and simulation are both concerned with the development and use of models, these fields evolved almost independently until relatively recently. Now, the potential contributions of AI to the development and application of simulation models are being considered more widely. AI techniques can playa variety of roles in the simulation process, Including:

- Knowledge representation in a model
- Decision making within a simulation
- Rapid analysis of simulator-generated outputs
- Model modification and maintained.

Finally the use of simulation methods in conjunction with decision analysis based on artificial intelligence is an area with almost limitless potential. This is more advanced than pure decision support, and is a longer-term concept.

A number of researches are looking at the use of AI tools to support the simulation process, particularly in the areas of model building, experiment planning, and analysis of results. Researches are creating simulation applications using AI tools such as OPS5 and KNOWLEDGE CRAFT. It seems that such tools offer great promise in the area of "rapid prototyping" of simulation models and allow the expert user to create "quick and dirty" models quickly. The authors is engaged in a research project to developed a "fast simulator" based on Petri-Nets and OPS5: the idea is that the production rule paradigm of OPS5 mirrors the firing of transitions within Petri Nets, and thus a simulation model written in Ops5 can be early created earl y from a Petri Net represent at ion of the system under study.

3.9.11- CAPSSIM / PES (Expert Simulation) - One of the most significant developments is the application of expert systems to simulation. The research community is very active and the results of this work are being implemented in commercially available simulation systems. The field of expert systems and artificial intelligence is very broad. Many different aspects of expert systems have relevance to simulation. At the risk of some over-simplification, the main points of similarity between expert systems and simulation and potential applications will be briefly discussed.

Expert systems differ from traditional computer programs in that the knowledge which is built in to the program is separated from the logic which processes it. Whereas in a FORTRAN program the knowledge of the program writer is embedded in the program itself, in an expert system the "knowledge base" is self-contained out with the program, and the program provides general routines to process that knowledge. The knowledge base consists of two distinct types of information, declarative knowledge, or facts which are known to be true, and procedural knowledge, or rules from which other facts may be deduced. The analogy is that in a simulation program, especially one structured on activities, the rules are within each activity, the facts define the status of the model, and, if the rule "fires", then new facts will result from the actions which can be carried out.

How expert systems and simulation should be inter-connected is a complex matter of software systems design. Among the variants the suggests are systems in which an expert system is embedded within a simulation program, or vice versa, and where an expert system is used as an intelligent front end for simulation.

The Linking of a generalized simulator with an expert system would, at least in theory, provide a enterprising systems design tool of unprecedented capability and utility. The Development of these aids as packages based on generalized simulators, rather than on specific models, would ease their construction.

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It is at the development stage that non-expert users need to be able to understand the model under construction. Often they have no interest in computers but do have a keen interest in understanding a complex system and in getting results. They need to see something which is readily comprehensible and clear enough to enable immediate validation, but in order to get the information on the computer in the first place user must communicate with it. If the machine could understand ordinary English typescript there would be fewer problems. Natural Language Understanding Systems (NLUSs) enable exactly this sort of communication to take place.

3.9.12- CAPSSIM / PESM (political Enterprise Simulation Software Management) After a review of the main types of package for enterprise simulation, it has been emphasized several times that it was not intended to give a comprehensive review of any specific package, but to illustrate the kind of facility provided, by reference to specific packages. Developing simulation packages have been towards:

- Making the package easier to use, by providing, for example, interactive model generators or enterprising-oriented front ends,
- Making the output of the package easier to understand, for example, by providing graphical animation of the simulation model and results in the form of graphs and charts.

Simulation Language - Is a programming language that is used to assist and simplify computer simulation.

Simulation languages help the user to develop a model because of their internal structure which is designed to define, interpret structure which is designed to models. In addition, they provide facilities which reduce the need for user to be familiar with list processing, logic, data retrieval and Statistically testing.

When more detailed is required, it wills necessary to proceed to the use of a general-purpose simulation language and the unique model that this implies. For most applications, where similar work has been done previously, a collection of modules of code with be available. Maximum use should be made of these to reduce the quantity of new code.

A general-purpose simulation language allows the model to be developed into as great a degree of detail as required. A modular approach *into* as great a degree of detail as required. A modular approach is usual, with modules covering the executive of the model, input and output, monitoring and Statisticalal blocks being provided by the language used. This approach is the technique suggested by the configuration of several simulation languages.

GPSS/B Modeling Language and its Application - The modeling language we study in this text, is an outstanding choice of language for modeling systems composed of units of traffic that compete with each other for use of resources. Numerous types of systems fit this description. Included are enterprising systems, communication networks, defense systems, civil systems, and queuing (waiting-line) systems in general.

FIG.3.2. IS AN EXAMPLE FOR BLOCK DIAGRAMMING FOR SIMULATION OF A POLITICAL ENTERPRISE (PE). THE PROGRAM HAD WORKED IN GPSS / H LANGUAGE.

GPSS/PC ANIMATOR - Minuteman Software offers both a CAD-based post processing animator and real time character graphics animator. These animators run *in* conjunct ion with GPSS/PC. The CAD-based animator use AutoCAD to create high-resolution wire frame style drawings. The character graphics mode animation was designed as a quick graphics display that can be used by the simulation analyst as a debugging tool. Both packages run in personal computers.

TESS and SLAM II - In the past two decades, modeling and simulation support has been provided by simulation languages such as SLAM II. with the advent of advanced database and graphics capabilities coupled with microcomputers as work stations, additional support can be provided to simulators and modelers. The extended Simulation-System, TESS, has been developed to support all aspects of a simulation project.

- A graphical network builder
- Automatic translation of a graphical network for execution by the SLAM II processor
- Procedure to convert a statement model to graphical form
- A graphical facility diagram builder to display schematic models of systems
- Procedures for defining rules that relate model events to actions portraying dynamics on a facility diagram
- Animated graphics depicting entity flow and resource change on facility diagrams
- A transparent database organization for data and summaries of data
- The input of SLAM II controls in a forms mode
- Procedures for storing simulation outputs in a database including entity and event histories
- A command language to perform functions on TESS data elements
- Command to obtain simulation outputs as plots, bar charts, range charts, histograms and pie-charts
- Standard Statistically analyses of simulation outputs to estimate the variance of a sample mean and confidence intervals
- Capabilities to manage data collected from a system and to output it in conjunction with simulation results
- A report generator to prepare simulation output reports.

3.7.13- CAPSSIM / PEHM (political Enterprise Simulation Hardware Management) - Before discussing simulation software it may be worthwhile to make some observations concerning the computer hardware on which the model will be run and the peripheral devices which are available. There are three basic possibilities:

- A mainframe or super-mini computer
- A personal computer
- A computer dedicated to some other purpose such as a CAD system.

If we are use a mainframe then we may be constrained be features of the operating system. Simulation programs are usually large and run for a long time. There may be limits on the size of program or length of run which we can run interactively during normal off ice hours. There may also be restrictions on the peripherals which the system will support. We may want to show a graphic picture of the system and the movement of components around the system. A graphics terminal may have to be acquired specially for this purpose. We will need to be sure that a computer will support its protocol. If the computer serves a large number of users the response of the system may be too slow. If the computer gives each user a small slice of its time at a time, then our graphic picture will freeze while it gives other users attention.

Personal computers are becoming increasingly popular for simulation modeling. They avoid the problems which can arise with multi-user hardware. Also their graphical capabilities are more precisely defined and generally easier to learn. On the other hand, PCs may have insufficient memory or may be too slow to permit us to do all that we would like in the model.

If we have a CAD system, we might consider running the simulation model on that system so that its graphical capabilities can be used. For example, if three-dimensional CAD software is available it might be used to advantage for simulation. Most CAD systems can be used for general-purpose programming, but it may be difficult to find someone with the necessary skills in both simulation and CAD system programming.

3.8- CIPSE-CAPSSIM Project - In CAPSSIM, a system is a collection of interrelated elements that work together to achieve a stated objective. A CIPSE system, for example consists of people, machines, spaces, procedures, information, and data that interact with the objective of building quality solutions in timely fashion and at acceptable rates. Similarly, a health care system consists of elements that can be described with such words as people, machines, spaces, procedures, information, and data, where the objective is to acceptable and/or restore the health of individuals at acceptable cost level. The system being simulated may only be in the design stage, or it may already exist.

In a CIPSE system, units of traffic might be units of work-in process, and the ,scarce (limited) resources for which units of work process compete Include people, machines, space in waiting area at machines, and the equipment used to transport work-in process from point to point in the system.

CAPSSIM is used for discrete-event simulation. A discrete-event simulation is one in which the state of a model {or of the system being modeled} changes at only a discrete, but possibly random, set of time points, known as event times. For example, an political order arrives at an order-filling system. The arrival of the political order beings is an event. It occurs at a point in time.

A CAPSSIM model takes the form of a series of statements {or, initially and on paper, diagrams representative of these statements}. The results of simulating with such a model are provided as information describing the current state of the model as it operates over time, and/or detailing the time ordered set of states through which the model has moved in reaching its present state, and/or summarizing the model's performance in aggregate terms at the end of a simulation.

A CAPSSIM model can be expressed as a Block Diagram, or as the statements equivalent of a Block Diagram. CAPSSIM modelers sometimes start the modeling process by constructing a Block Diagram of the model. statements corresponding to the Blocks in a Block Diagram {Block statements} are then prepared and are supplemented with additional types of statements known as control statements, and perhaps with other types of statements known as Compiler Directives. These additional statements provide supporting information about the model and describe the plan for its experimental use. The resulting collection of statements, known as a Model File, is then executed by CAPSSIM under computer control.

A Block Diagram is a collection of figures {Blocks} with one-way paths connecting them. The paths are shown as directed line segments. (A directed line segment is a line with an arrowhead at one end of it.) Each type of Block plays a particular role in a model. There are more than 60 Block types in CAPSSIM, each with its own distinctive shape.

Units of traffic move along the one-way paths in a Block Diagram. The name Transaction is given to a unit of traffic CAPSSIM. The movement of transactions from Block to Block as a simulation proceeds is a vital part of a CAPSSIM.

The model is built by selecting appropriate Blocks from the available types and sequencing them in a Block Diagram to form patterns corresponding to patterns in the system being modeled. The blocks are used to represent such things as system resources, information-gathering, and decision-making capabilities. The physical and logical aspects of the system being modeled, and the type of information that the model is to provide, determine which Blocks are used in constructing the model. When the model is executed by a computer, it is the movement of units of traffic from Block to Block that is analogous to (simulate) the movement of traffic through the system being modeled.

The simulated schedules generated by the program are designed to serve as decision aids for project planners. The effects of different activity time estimates and resource allocation options can be easily studied with CAPSSIM prior to operational implementations in an actual project.