See this page also at <http://tinyurl.com/dx2sqq>.

## 3.1 Inception of Globally Distributed Simulation with Beowulf Mini Supercomputer:

Earth Simulator built by NEC of Japan at US$350 million can simulate environment of the entire earth with the use of real-life climate data from satellites and ocean buoys [TIME.com, 2002]. Albeit the world acclaim on its speed, however, because of its price and size (four tennis courts), we cannot expect to mass-produce this simulator in the near future to install in every participating countries of our GCEPG project. Luckily, as taking the principle of "Leave the Driving to Us," the motto of the Greyhound Bus Company mentioned above, the distributed computer simulation with the network of the clusters of inexpensive personal computers is now available, as I advocated since the fall of 1972 [Utsumi, 2008].

In contrast to the single supercomputer as the Earth Simulator, the current and future trend of high performance computing is to build a cluster of personal computers with inexpensive off-the-shelf (or even second-hand, used) PCs. The parallel processing of this cluster system divides a complex problem into smaller component tasks, as similar to distributed computer simulation system mentioned above. This scheme of PC cluster is now called the Beowulf mini supercomputer.

David Miller, founder of Denelco in Denver, CO was the general chairman and I was the program chairman of the first Summer Computer Simulation Conference (SCSC) in Denver in 1970. I then was the general chairman of the SCSC in Boston in 1971. In the spring of 1973, there was a simulation conference in Tokyo, and David and I discussed about the future of computer.

He chose to construct the Heterogeneous Element Processor (HEP) with 50 Central Processing Units (CPUs) of PDP/11 mini-computer in a single box, which was the first commercially available parallel processing supercomputer in early 1970s. Prior to this, he consulted me of his venture. My response was why not distribute those CPUs around the world and connect them with global data telecom network, e.g., DARPANet (Department of Defense/Advanced Research Project Agency Network), which was the predecessor of Internet. My suggestion (which is a similar one to global grid computing network of nowadays [McLeod, 2000] (Fig. 3.1)) was based on my experiences with analog and hybrid computers over a dozen years by then, i.e., as making analogy between computing elements of analog computer with CPUs of digital computer, and of wiring on the former to telecom network.

# Initiation of GRID Concept

**Excerpt from**
**SIMULATION IN THE SERVICE OF SOCIETY (S3),** Simulation, September 2000
**John McLeod** A Technical Editor **Suzette McLeod** A Managing Editor

**Power (?) Grid!** **Mission Earth (M/E)**

As readers may have noticed, this writer has been interested in the desirability/possibility of someone, or some agency, developing a global communication network since my first discussing the matter with **Tak Utsumi** in **1972**. At the time Tak and I were both primarily interested in the use of such a network for the **distributed simulation of "Peace Gaming,"** as contrasted with the war games so widely used by the military of all countries. However, my early enthusiasm had to be redirected from personally contributing to such an undertaking when I realized the enormity of the technical problems. But **Tak has persevered and has successfully demonstrated many components of a necessary infrastructure.**

Tak and his colleagues have had to raise funds from any sources that they could, as well as pushing back the technical frontiers. But recently several powerful publicly funded organizations have entered the picture. NASA of course has a worldwide communication network which is necessary in support of its space program. However, I understand--perhaps mistakenly--that it is to be made available commercially. More on that when I learn more.

And now we have the following article describing a communication network which it seems to me is misnamed, and I wonder how many others, think of a power grid as a network for the distribution of electrical power. Be that as it may, the description seems to be that of an information network, and the list of participants seems to indicate that it is supported largely by the National Science Foundation. -JM

**Building an Information Power Grid ....**

http://makeashorterlink.com/?H241159B9

Fig. 3.1: Initiation of GRID Concept
< Initiation of GRID Concept copy.pdf >
<http://tinyurl.com/cpgfdm>

Incidentally, I had a privilege of exclusively using then the world largest hybrid computer (made by Bechman Instrument Co., **) for a half year, which was later used for the simulation of the first lunar landing by Eagle at the Massachusetts Institute of Technology in late 1960s. Both the hybrid computer and HEP were designed by Dr. Maxwell Gilliland. Almost two decades ago, I had introduced HEP to NEC, which then produced the Earth Simulator mentioned above.

> (**) two analog computers with 500 amplifiers for each with Xerox's Sigma real time computer with 32 K words memory. This machine was priced at US$ 1.5 million for NASA, but NASA did not have such money at that time so that it was sitting at Beckman's research lab in Richmond, California. It was later moved to the Lincoln Lab of the Massachusetts Institute of Technology and used to simulate the EAGLE lunar landing by Armstrong. I used it as if for my exclusive use for almost a half year to simulate the chemical reaction to extract oil from shale rocks, which reserve in Rocky Mountain is almost same as the one of Saudi Arabia. This was a major project of Mobil Oil at that time — alas, this project was not materialized because it was very difficult compared with the tar sand project in Canada.

This cluster concept promises to revolutionize the computing field by offering tremendous processing power to any research group, school or business. This is, in a sense, a poor-man's approach since the cluster can often be built with less than $50,000, which is about one tenth the price of a comparable commercial supercomputer. Compared with the exorbitant price of Earth Simulator at $350 million, those commodity clusters – networked arrays of standard computing subsystems – are perceived as the only economically viable pathway: they require little additional development in spite of the programming difficulties and communications delays inherent in using clustered systems.

The Beowulf concept (PC-Cluster) is an empowering force. It wrests high-level computing away from the privileged few and makes low-cost parallel-processing systems available to those with modest resources. Research groups, high schools, colleges or small businesses can build or buy their own Beowulf clusters, realizing the promise of a supercomputer in every basement, for example;

> Hiroshima University in Japan has 500 PCs which are used with Microsoft Window operating system by students in day-time, and which are converted to Linux operating system to connect all of them to be a clustered supercomputer in night time. The Japanese Ministry of Education once announced a plan to connect PCs in K-12 schools in weekends to form a supercomputer for local researchers and scientists. POWUA <http://tinyurl.com/3fl5k4> in Milan, Italy provides supercomputing power readily to ordinary people, e.g., scientists, academicians, students, etc., even with some philanthropic intention of providing them with 20% of capacity at free of charge for educational, healthcare and humanitarian purposes.

As interconnecting those Beowulf mini supercomputers around the world via Global Broadband Internet (GBI), researchers of GUS (see below) can conduct joint research across continents and oceans as tapping into a "computational grid" that will work like a power grid: users will be able to obtain processing power just as easily as they now get electricity from "cloud computing network." This is the next future of Internet development.

## 3.2 Unique Leading Edge Technology of GCEPG Project:

With global GRID computer networking technology and Beowulf mini-super computers of cluster computing technology, we plan to firstly develop a socio-economic-environmental simulation system and then a climate simulation system in parallel fashion, both of which are to be interconnected through broadband Internet in global scale (Fig. 2.1). This two-tier system will ensure comprehensive system for each by their experts.

In the case of conventional GRID computing network, a central computer administers subordinated computers as distributing to them similar software for utilizing their spare/idle computing power. The number of subordinated computers could be a million or more for searching a prime number or for the Search for Extraterrestrial Intelligence (SETI) project, etc. However, on the other hand, in our GCEPG project, various dissimilar simulation models scattered around the world will be interlinked through Internet to perform as if a single simulation in global scale (Fig. 2.1), where each of those models will be autonomously developed and maintained by the experts of their countries, sectors, and fields, etc.

The basic premise of policy analysis and assessment is "prediction," which is also the most common denominator of various simulation models. Hence, all of the simulation models (by either System Dynamics, Econometrics, Input-output methodologies, etc.) would produce time-series table. The key development tasks of this project are the followings among distributed simulation models through Internet;

(a) To produce the way of inter-linkages of variables,
(b) To interface of models (Fig. 3.2),

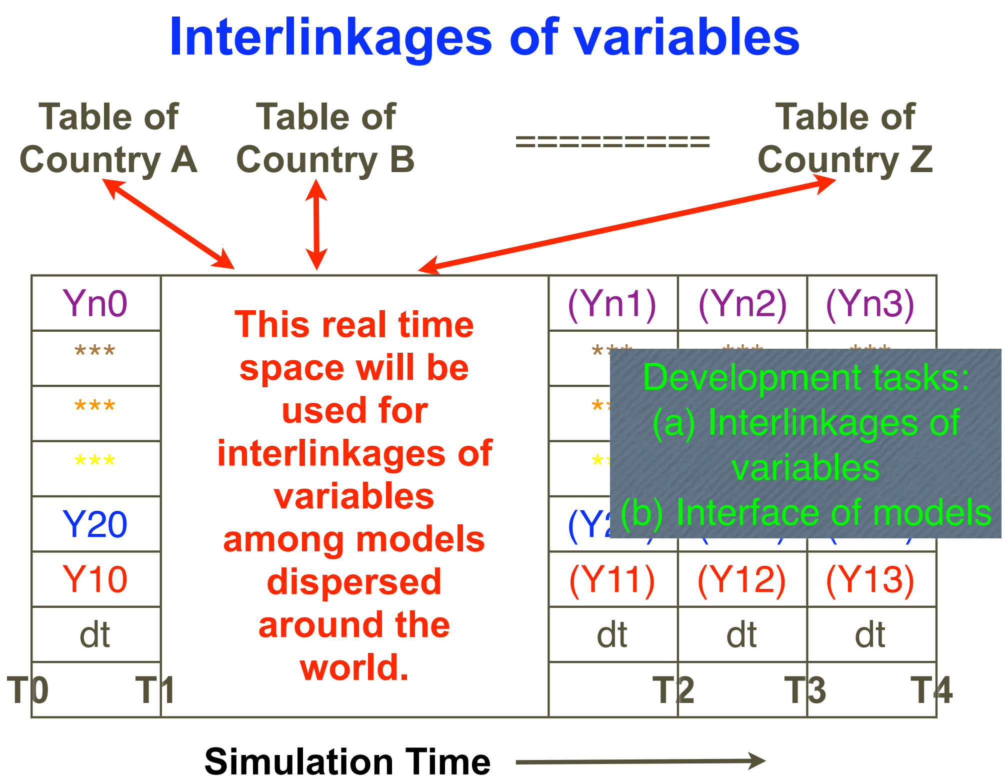


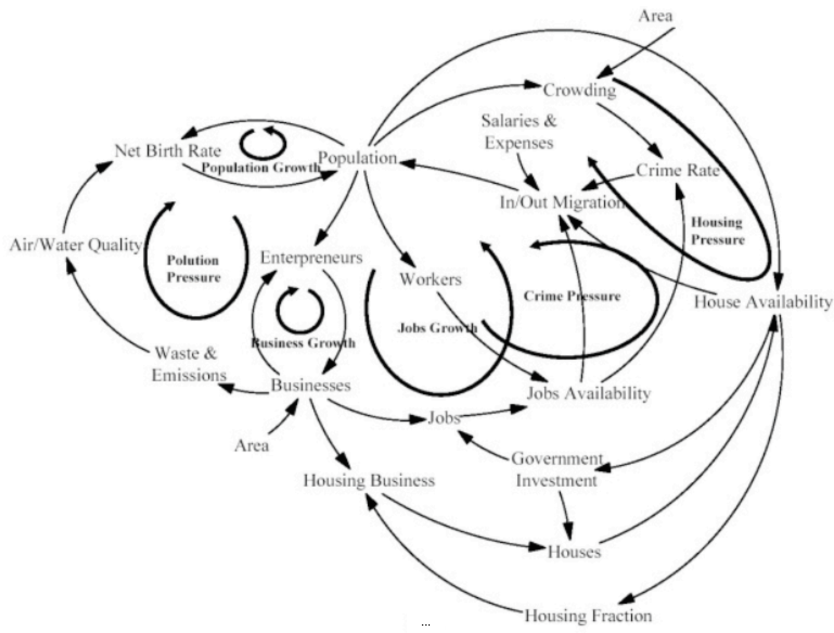

Fig. 3.2: Linkages of variables
< Interlinkages of variables copy.pdf>
<http://tinyurl.com/cvvjvb>

### 3.3 Distinctions and Effectiveness:

In addition to the difference of our distributed simulation technology from the conventional GRID computing technology briefly mentioned above, our approach will fulfill the principles of gaming/simulation mentioned in the Section 2.3 above. These principles are often forgotten or neglected in spite of the fact that the construction of gaming/simulation models are very time consuming with highly intellectual labor, and hence very expensive projects – a good example is the Earth Simulator mentioned above.

Although we plan to utilize any kind of simulation models as far as they produce time series table as mentioned above, system dynamics methodology would be our prime choice for understanding complexity of socio-economic, bio- and eco-systems to evaluate how alternative policies affect growth, stability, fluctuation, and changing behavior. The cause-and-effect analysis of system dynamics methodology (Fig. 3.3) based on feedback theory, along with computer simulation modeling, is particularly the best tool to understand the inter-relatedness and inter-dependency of various complex world phenomena. The main purpose of our project is to attain global peace, and for this, we need to foster the understanding of inter-relatedness and inter-dependencies of various world phenomena among young would-be decision-makers, who would be participating in our peace gaming through worldwide Internet.

# Population Growth in City Development




Barlas, Y., System Dynamics: Systemic Feedback Modeling for Policy Analysis

Fig. 3.3: Example of cause-and-effect diagram “Population Growth in City Development”
<Population Growth in City Development_NB copy.pdf>
<http://tinyurl.com/d5yh25>

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