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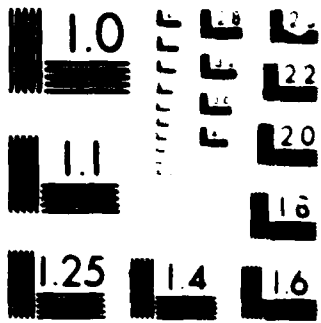
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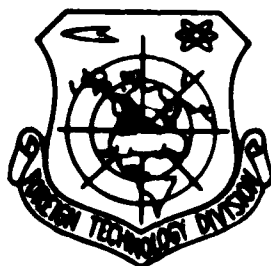
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FUTURE AND DEVELOPMENT
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→ *China Handbook*

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THE DEVELOPMENT OF ELECTRONIC SCIENCE AND TECHNOLOGY

Wu Hongshi

(I)

Strictly speaking, there is a difference between the two terminologies of electronics and electronic technology. Electronics belongs to the systematization, organization and regularization of scientific knowledge, and concentrates on the conducting of systematic research from a theoretical standpoint. Whereas electronic technology is a kind of technique and emphasizes application of putting electronic methods and means to practical uses. We do not stringently distinguish these two in a literal sense in this paper.

Since the invention of ^{the} vacuum tube in 1906, the term "Electronics" has been proposed by people. But as a scientific discipline, the thriving development of electronics and the extensive application of electronic technology were actually started in late 30's and early 40's, using the years during World War II as a starting point.

Based on its earliest definition, electronics primarily studies the devices composed of movement of electrons and utilizes the circuitries and systems of these devices as well as their applications in communications, broadcasting and industrial control. Since the 40's, the rapid development of technologies such as microwave, impulse, laser, semiconductor, integrated circuit, computer, etc. has given electronics a newer and broader definition. It not only includes the familiar whole machines and equipment such as communications, broadcasting, television, navigation, electronic confrontation and high-frequency and microwave industrial heating, etc., transmission and processing of information, theories and technologies in electric circuits and electromagnetic field, various vacuum tubes and solid state electronic devices, etc. but also in-

cludes those newly developed disciplines such as automatic control and computer which intertwine with and interdepend upon other disciplines such as information theory, control theory, systems engineering, etc.

The effects and influences on the entire society by electronic technology are becoming more and more significant. Now people usually call the invention of ^{the} steam engine in the latter half of the 18th century(1764) the first technological revolution. It expanded human physical power and used machines to replace manpower. The discovery of electromagnetic induction in the 19th century(1831) and the construction of power plants, power supply systems and application of electric power in its latter half is called the second technological revolution. Through this technological revolution, mass production was conducted and productivity upgraded by relying upon electricity generated from large utilization of energy sources such as petroleum and coal. The extensive application of electronic technology and computer in this century again made mankind embark on a new technological revolution, and is called the third technological revolution. Through this technological revolution, the productivity is upgraded from the basis of expanding brain power and reducing energy consumption.

Steam engine and electricity realized the mechanization of manufacturing processes, yet human intervention was still required for monitoring and adjusting the manufacturing processes. The worker must constantly attend to the motion of machine, use eyes, ears and nerve system to directly obtain information for the manufacturing processes, then process this information by the brain to make decisions as to whether the operating conditions of machine should be changed, and carry out the decision by using the hands to directly adjust machine. The advent of computers in this century has caused the information obtained through electronic technology to be processed in a computer, and then the execution signal is issued. Since the computation of a computer is fast and storage capacity is large, it can perform optimum control of manufacturing process and conduct monitoring control of the entire manufacturing facility,

thereby achieving full-scale automation of the entire enterprise and enterprising systems, and greatly upgrading productivity.

Since the majority of the problems handled by electronic technology and computer can be categorized as collection, transmission and processing of information, the new technological revolution is also called the information revolution. The development of this information revolution relies more on the unlimited intelligence resources, i.e. the knowledge and thought of human beings unlike the two previous revolutions which primarily depended upon the limited natural resources such as steel, petroleum, coal, etc. Therefore, the developmental potential of ^{the} information revolution is limitless and boundless. It should also be noted that the influence on the entire society by the information revolution is extremely vast: it permeates into all natural science, technical science, engineering construction, social science, national defense and people's daily life.

When studying population problem in sociology, factors such as birth, death, age change, ratio between the sexes, difference in life expectancy....are considered. A mathematical model can be established using differential equations or difference equations to obtain the developmental trend of population. Meanwhile, the rate of population growth, time required for population to stabilize, its number, etc. can be controlled through controlling women's average childbearing rate and childbearing model(to bear child at what age).

The adjustment of national economy is a problem of macroscopic economic theory. It studies the structure of national economy and how to optimally stipulate plan and policy. Similarly, a mathematical model with multiple variables can be established, and then use a computer to conduct simulation experiments and forecast future development, thereby making policy-making more scientific.

It should be pointed out that, for the problems within social

science, since the system under study (population system, economic system) are all of nonlinear and random systems, the data information are all obtained through periodic sampling within a specific time and thus sampling frequency is low. Moreover, there are changes in statistical basis and the statistical time is not long; therefore, parameters in the equations and the equations themselves all have specific inaccuracies.

Recently, due to the utilization of some of the methods in information theory, control theory and systems engineering, disciplines such as history, philosophy, politics, psychology, etc. have also become similar to natural science that it is possible to establish mathematical methods for conducting quantitative studies.

(II)

The key point in the development of electronic technology in the 80's is microelectronic technology. Specifically, it includes integrated circuit and computer as well as various automation devices including robots.

Ever since the onset of world-wide energy crisis in 1973, the capitalist world has generally slumped into sustained economic crises. Traditional industries such as steel, automobile and construction have in general sunk into bad times, causing insufficient construction startup, enterprise bankruptcies and mass worker layoff. However, the microelectronic industry in developed Western countries is thriving, with annual growth exceeding 20% and even as high as 50%. Currently, the gross products of microelectronic industry of the U.S., Japan, and Western Europe have taken up 1.5% of their national gross products, and the gross products of microelectronic industry of the U.S.S.R., Eastern Europe, India and South Korea have taken up 1.0% of their national gross products. According to estimation, it is possible that the microelectronic industry may develop into the world's largest industry by the end of the 80's.

The typical products such as microprocessor and microcomputer of the microelectronic industry have extensive applications and their costs are inexpensive. Their applications have already penetrated into the aforementioned realms. The development of this industry does not rely on energy sources, but primarily on intelligence resources; therefore, it is especially suitable for development in our country.

We must strive toward the development of research in computer application, contracted production and enhance the research and production of software. One million software packages were sold in the U.S. in 1979 and were worth 200 million U.S. dollars. By 1985, it can reach 10 million packages and be worth 2 billion U.S. dollars; and it will increase 10 times by 1990. Currently, there are 1.5 million professionals engaging in software development in the U.S., whereas there are only close to ten thousand people in our country.

We must spare no effort in developing ^{the} microprocessor and its applications. We must develop the research and manufacturing undertakings of robots with artificial intelligence.

We must research and manufacture (GaAs) material (it opens and closes 3-4 times faster than Si). We must develop the research in submicron exposure technology and study multi-layered IC and super-conductance IC, etc.

There are some other developmental key points in addition to the aforementioned microelectronic technology, for instance:

(1) Fiberoptic Communications

Multi-mode optical fiber can transmit more than 20km without relay and with wide-frequency band and little losses. Single-mode optical fibers can transmit more than 55km.

Now fiberoptic components have already been mass-produced and from 1975 to 1980 the price has dropped by 10-fold. By estimation,

it will drop another 10-fold by 2000 (equivalent to 20 cents Renminbi per meter). It will gradually replace copper and by 2000 fiberoptics will be predominant.

Optical fibers are not only used in multi-channel communications but are also used in navigation systems and weapon delivery systems. The communications between commanding post and weapon control system, and from point to point through various above-ground and underwater means will all depend on fiberoptics.

(2) Photoelectronics

It means laser, optical measurement instruments, infrared measurement instruments, optical magnifying device, etc. The problem of the optical computer must be solved to make it possess high speed, be multi-purpose and ^{have} large capacity. Integrated optics (developed in the 70's) are utilized to provide fiberoptic communications with a series of components such as switch, coupling adjuster, power distributor, power integrater, etc., and the frequency spectral analyzer has been produced for applications in military reconnaissance and electronic confrontation. The optical circuitry and opti-coupling concepts provided by integrated optics are the bases for an optical computer. Recent application of fiberoptic coupler in opti-logic door circuits and the realization of opti-logic, especially the research and manufacturing of opti-crystal tube, have pushed photoelectronics into a brand new era.

(3) Superconductance Electronics

The conservation effect was discovered in 1962. The superconductance quantum interference device (SQUID) made by conservation has realized precision electric current standard in low-frequency section and has conducted measurements of gravitational force, geomagnetism and biomagnetism.

In medium-frequency range, the superconductance cylinder is adopted to serve as steady-frequency oscillator, parameter amplifier,

rapid measurement of instantaneous signal, microwave frequency simulation character exchanger, and logic and memory integrated circuits.

In the high-frequency section, the range from millimeter wave to infrared is served as extrapolation oscilloscope and used in radio-astronomy.

In the area of superconductance computer, its operational cycle is 2ns, whereas the operational cycle of ordinary high-performance computer is about 30-35ns.

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BIO-MEDICAL ENGINEERING AND FUTUROLOGY

Liu Chang

What is bio-medical engineering? Simply stated, it is the application of principles and methods of natural science and engineering technology to understand, from ^{an} engineering angle, the life process of all living things (medical science is primarily for human beings), and solve the many practical problems from this angle.

First, let's use genetic rearrangement (i.e. DNA rearrangement) to roughly reveal the truth of this discipline. To rearrange genes can not only greatly increase nutritional value of existing crops, vegetables and fruits, but can also produce single-cell protein by employing the production style of a factory. The breakthrough in this technology can provide the majority of the world population with inexpensive edible protein, and the food problem in futurology is thus resolved. Gene rearrangement will create, according to mankind's wish, unseen, unheard of and strange new species such as pigs as big as cattle, sheep of various colors,..... These is no longer science fiction.

The second major problem that futurology studies is the population problem. People wish to control the population while upgrading quality. Questions such as selective breeding, disease prevention, anti-senility, extending life expectancy, etc. will all find their answers in bio-medical engineering. Questions such as protein synthesis, human genetic configuration, human chromosome structure, cell reproduction process, growth development and aging and even the beginning of life, the most life-threatening tumor and cardiovascular diseases will be explained. Certain diseases and genes are closely related. Many hereditary diseases are caused by abnormal genes carried by parents and once bearing children, abnormalities will show up on them. How do we identify problems and solve problems before the child is born? This must rely on gene inspection. Gene rearrangement will solve the treatment (repair) problem of genes

with defects, i.e. using external or artificially synthesized genes to mix into certain cells and combine with the original genes of the cells, thereby causing changes to the genetic information carried by their genes, just like repairing broken cells. If certain hereditary metabolic disease, e.g. lacking certain enzyme, is encountered, ^{an} antibody carrying gene with this kind of enzyme can be added into the cell for cultivation and thus make the defective cell obtain this kind of gene, and if this cell can be replanted back to the body, then the hereditary disease is cured. Presently, the problem of how to transplant reproductive cells has not been solved. If this problem is resolved, mankind will enter from organ transplant into a brand new era of cell transplant.

The third major problem of future world is the environmental problem, primarily the problem of remedying pollution, and the breakthroughs in this area by bio-medical engineering are encouraging. Utilizing bacteria to treat waste water and garbage will be realized in the 90's at the latest. This waste treatment method not only has high efficiency but is also inexpensive. Utilizing bacteria to select a source and produce lubricants, pesticides, biological products (vaccine, protein, insulin, growth stimulant and antibody) is no longer science fiction.

Bio-medical engineering will incorporate all the achievements in disciplines such as electronics, information, new material, etc. and become the major user of all these new technologies. The current renovation in medical photography that shocks the medical profession is an outstanding example. The well-known CT scan, magnetic resonance photography, three-dimensional ultrasonic photography, etc. can detect tumors of several centimeters in size at any deep organism in the human body thereby making early detection and treatment of tumors a reality. Diseases with the highest occurrence frequency such as stroke and brain blood clot can also be accurately located through this inspection. Disciplines such as artificial organs and biological material are a big branch in bio-medical engineering. Until recently, the artificial heart that shocked the world had been in operation in American dentist Dr. Clark for three months. The manufacturing of artificial

organ has entered the maturity stage. By estimation, around the year 2000, all organs can be manufactured except for the brain. Since biological material is in contact with blood and organisms, its requirements are much more stringent. It must notably be compatible with blood and ^{the} organism but also must possess flexibility and strength. The excellent existing industrial materials such as stainless steel and titanium alloy of the metals, the recently developed memory alloy, ceramics and carbon element, and silicon rubber, polyammoniac enzyme and nylon of the polymers, etc. have all been extensively utilized in artificial organs.

Similar examples are too numerous to mention and the aforementioned is just a small portion of them. Our purpose is to illustrate the important position occupied by bio-medical engineering in futurology. The era of a new technological revolution has arrived and the future is beckoning. We should strive forward to catch up.

Author's Affiliation Beijing Children's Hospital

LITERATURE

· 简讯 · 河南省未来研究会筹委会于8月1日至4日在郑州召开了“新技术革命和社会经济发展战略学术讨论会”。并宣布筹委会正式成立，省科委副主任李明仁任会长，杨林军任秘书长，挂靠在省社会科学院经济研究所。

BIO-INTEGRATED CIRCUIT AND BIO-ELECTRONIC COMPUTER

Pan Song

Since the birth of the first electronic computer, it has experienced several stages---electronic tube-type, crystal tube-type, integrated circuit-type and large scale integrated circuit-type, over the past thirty-odd years, and now it is into the very large integrated circuit. But some of the experts now believe that modern industrial microelectronic technology is nearing its limit. The industrial integrated circuit production technology has placed 250 thousand electronic components in an area of one square millimeter. It is difficult to further increase the density and new integrated circuit technology must be found. Where does the hope lie? It lies at manufacturing "bio-integrated circuit", i.e. to use living things themselves to create new semiconductor materials, or the use of living organisms themselves as integrated circuits, and then applied to ^{an} electronic computer to form a "bio-electronic computer". Is this possible?

According to current scientific studies, this is not only possible but also will be the development direction of future microelectronic industry. For example, American biochemist Dr. Jim Markalear has developed the manufacturing technology for this kind of bio-integrated circuit and has obtained patent right. For this, he established a "Bio-Electronic Computer Company" which has been approved for doing business and has started the research of "bio-computer" using the method he had invented. Allegedly, the operational speed of this computer is 1,000 times as fast as the biggest and fastest existing electronic computer, and yet its volume is only one cubic centimeter, small enough to be placed in a small match box and hidden in the pocket; it can also be planted in the heart of a human body to correct abnormal heart rhythm; planted into the eyes of the blind to restore eyesight; planted into human brain to cure paralysis. Of course, these are still fiction at the present, but not without scientific basis.

This kind of bio-integrated circuit and bio-computer can not be

produced by ordinary industrial electronic technology; they must be produced using biochemical method. Take the bio-integrated circuit manufactured by Markalear as an example: it is being manufactured in six steps: 1. first use a piece of germ-free organic glass as the base; 2. polymerize "amino acid protein" single molecule layer on the glass base to cover it up; 3. coat a thin plastic material as insulation layer over the aforementioned single molecule layer; 4. expose under electronic beam to engrave the protein and cause it to produce several crevices with each crevice several dozen milimeters wide and with spacing between crevices 200-250 milimicrons; 5. plant another kind of electronically charged working protein onto the tip of active amino of the polymerized amino acid protein; 6. coat another layer of thin silver layer on the exposed protein in the crevices and through it, the impulse electronic information is transmitted to protein working molecules.

After initial success in manufacturing the Markalear "bio-integrated circuit", it was found that the circuit would not shortcircuit and that it possessed specific functions, thus attracting the interest of computer experts of the world. Therefore, one hundred-odd experts gathered in Washington, D.C. of the U.S. in November 1983 to investigate the possibility of producing the bio-computer using this kind of bio-integrated circuit. They believe that the performance of a computer of one cubic centimeter composed of one soup-spoonful of organic molecules is possible to be much more superior than the computer made by very large integrated circuits.

Polymerized amino acid protein is artificially synthesized protein and is of single amino acid molecule. The bio-computer made by the bio-integrated circuit which in turn is made by the protein has a size of only one cubic centimeter, yet it has a memory storage capacity that is equivalent to a giant computer as big as a building. Someone has made such a speculation that the information learned by a person during his lifetime from elementary school to graduation from college can be stored in the bio-electronic computer with a size of one cubic

centimeter. If this bio-computer is carried or planted in the brain, then a person can become learned without the help of teachers and possesses a knowledge reserve equivalent to graduating from college.

LITERATURE

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