

ENCYCLOPEDIA OF 20TH-CENTURY  
**TECHNOLOGY**

Volume 1  
A-L

Colin A. Hempstead, Editor  
William E. Worthington, Jr., Associate Editor

**ROUTLEDGE**  
NEW YORK AND LONDON

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Biopolymers  
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Breeding, Plant: Genetic Methods  
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Genetic Engineering, Applications  
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Computers, Hybrid  
Computers, Mainframe  
Computers, Personal  
Computers, Supercomputers  
Computers, Uses and Consequences  
Computer–User Interface  
Control Technology, Computer-Aided  
Control Technology, Electronic Signals  
Error Checking and Correction  
Encryption and Code Breaking  
Global Positioning System (GPS)  
Gyrocompass and Inertial Guidance  
Information Theory  
Internet  
Packet Switching



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 Radionavigation  
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 Buildings, Designs for Energy Conservation  
 Buildings, Prefabricated  
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 Constructed World  
 Construction Equipment  
 Dams  
 Experimental Stress Analysis  
 Fire Engineering  
 Oil Rigs  
 Power Tools and Hand-Held Tools  
 Skyscrapers  
 Timber Engineering  
 Tunnels and Tunneling  
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**Electronics and Electrical Engineering**

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 Calculators, Mechanical and Electromechanical  
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 Biomass Power Generation  
 Electrical Energy Generation and Supply, Large Scale  
 Electrical Power Distribution  
 Electricity Generation and the Environment  
 Fossil Fuel Power Stations  
 Fuel Cells  
 Hydroelectric Power Generation  
 Nuclear Reactors: Fast Breeders  
 Nuclear Reactors: Fusion, Early Designs  
 Nuclear Reactors: Fusion, Later Designs  
 Nuclear Reactors: Thermal, Graphite Moderated  
 Nuclear Reactors: Thermal, Water Moderated  
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 Cameras, Digital  
 Cameras, Disposable  
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 Cameras: Lens Designs, Wide Angle, Zoom  
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 Film and Cinema: High Fidelity to Surround Sound  
 Film and Cinema: Sets and Techniques  
 Film and Cinema: Wide Screen Systems

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 Farming, Growth Promotion  
 Farming, Mechanization  
 Fertilizers  
 Fish Farming  
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 Food Preservation: Cooling and Freezing  
 Food Preservation: Freeze Drying, Irradiation,  
 and Vacuum Packing  
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 Angiography  
 Antibacterial Chemotherapy  
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 Alloys, Magnetic  
 Ceramic Materials  
 Composite Materials  
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 Nanotechnology, Materials and Applications

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 Cryogenics, Applications  
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 Gender and Technology  
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 Materials and Industrial Processes  
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 Automobiles, Internal Combustion  
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 Civil Aircraft, Supersonic  
 Dirigibles  
 Fly-by-Wire Systems  
 Helicopters  
 Highways  
 Hovercraft, Hydrofoils, and Hydroplanes  
 Internal Combustion Piston Engine  
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 Rail, Electric Locomotives  
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 Rail, Steam Locomotives  
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 Missiles, Defensive  
 Missiles, Long Range and Ballistic  
 Missiles, Long Range and Cruise  
 Missiles, Short Range and Guided  
 Missiles, Surface-to-Air and Anti-Ballistic  
 Nuclear Reactors: Weapons Material  
 Radar Aboard Aircraft  
 Radar, Defensive Systems in World War II  
 Radar, Displays  
 Radar, High-Frequency and High-Power  
 Radar, Long Range and Early Warning Systems  
 Radar, Origins to 1939  
 Sonar  
 Submarines, Military  
 Tanks  
 Warfare  
 Warfare, Biological  
 Warfare, Chemical  
 Warfare, High Explosive Shells and Bombs  
 Warfare, Mines and Antipersonnel Devices  
 Warplanes, Bombers  
 Warplanes, Fighters and Fighter Bombers  
 Warplanes, Reconnaissance



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# Editor's Preface

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All editors of encyclopedias are faced with the problem of what to include. Even if the title is agreed and the numbers of volumes and pages have been decided, the sum of possible entries could be very large. In the case of the *Encyclopedia of 20th-Century Technology*, the editor decided that in order to construct a logical and consistent set of entries it was necessary to adopt what could be described as an analytic framework. During the 20th century a plethora of manufactured articles have appeared for which the real costs have continuously fallen. The products in industrialized societies have become universal, and many of the good ones are within the reach of a large proportion of humanity. In keeping with this democratic trend of the century it was decided that people and their experiences with technology should be central to the encyclopedia. Readers are urged to read the entries in the light of the humanistic core.

An examination of people and their lives led to six broad, related areas of society from which the four hundred entries that comprise these volumes could be derived. The type of analysis carried out is indicated in the diagrams on the next page. The first shows the six basic areas; the second diagram is an outline of the detailed application for the category FOOD. Five or six levels of analysis allowed the definition of headers that provided the individual entries. Of course, entries could be found in two or more basic areas or could be related to others: entries in refrigerating in the domestic situation as found in food preservation would lead to entries in the technology of refrigeration *per se*. Thus the contents were defined.

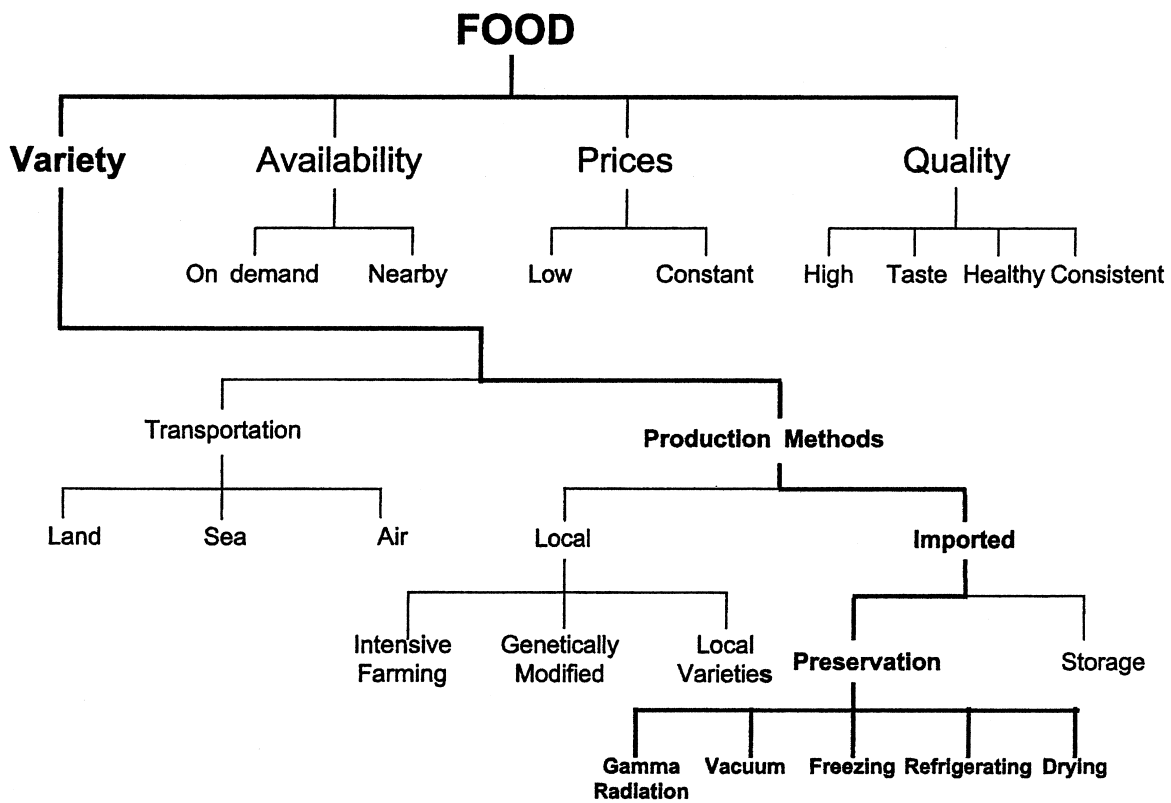
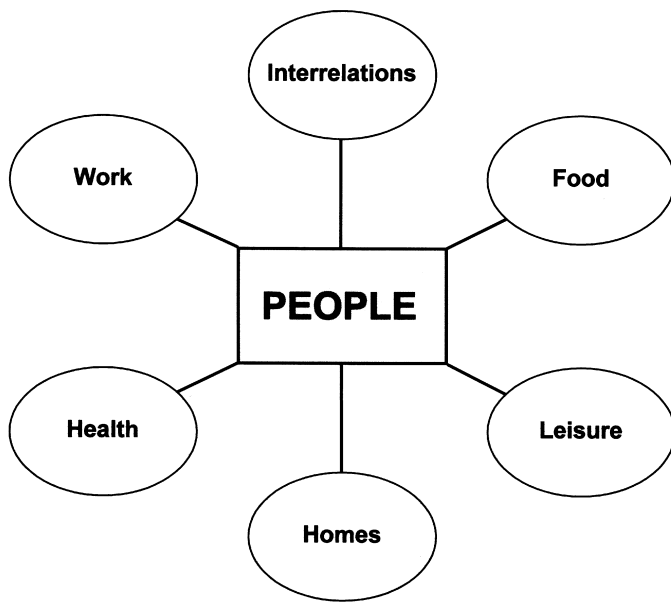
The encyclopedia contains two types of entries. The greatest number of entries are of 1000 words, and as far as possible these standard entries are devoid of interpretation. Nevertheless, it is recognized that all history is redolent of the era in which it is constructed, and this encyclopedia is of its own particular society, that of Western industrial. The

factual nature of the standard entries is leavened by longer essays in which historical and interpretative themes are explored. Among other things, these essays describe and analyze the relationship between society and technology, touch on the modern debates on the nature of the history of technology of history, and relate what people expect of the products of modern industrial civilisation.

The encyclopedia is concerned with 20th-century technology but not with 20th-century inventions. The technologies included are those that had an impact on the mass of the population in industrial societies. So many technologies invented in the 19th century did not begin to impinge markedly on many lives until the middle of the 20th century, so they are considered to be of the 20th century. Similarly, many products in the constructed world are old conceptions, transformed by modern materials or production methods. They have found a place in the encyclopedia. The inclusion of pre-20th-century products compares with the exclusion of recently developed technologies that have yet to have any effect on the mass of the public. However, the encyclopedia is not intended to be futuristic. In the 20th century, scientific engineering came to majority, and many if not all the products of modern technology can be seen to be the results of science. However, there are no entries that discuss science itself. Within the essays, however, science as science related to each subject is described.

Even with four hundred entries, the encyclopedia is not canonical, and gaps will be noted. However, the standard entries, the interpretative essays, and the lists of references and further reading suggestions allow readers to appreciate the breadth and depth of the technology of the 20th century.

**Colin Hempstead**



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# Associate Editor's Preface

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Technology is a vital subject. It grows continuously. New technologies are introduced, existing technologies evolve, and the outmoded are abandoned. Looking dispassionately at technology, it is always exciting, for it is the product of human ingenuity. For the purposes of this encyclopedia, we felt it could not and should not be discussed devoid of its human element. It is breathtaking to consider the panoply of developments which occurred during the last century, but it is necessary to recall that these developments did not take place in isolation. It was our desire to see that events, where possible, were described in context. Thus, you will find names, places, dates, and events critical to the development of a particular technology. The reader will note that some entries contain a surprising amount of information on 19th-century events. This was appropriate, for some 20th-century technologies were firmly rooted in that earlier time and can be best understood in light of the past. To avoid a deadly dull recitation of formulae and regurgitation of dry facts, we sought to give the reader the broadest possible picture.

The encyclopedia was created for the lay reader and students as well as for historians of science and technology. In light of this, we attempted to minimize the use of the jargon that tends to grow

around some technologies. Although many of the subjects are highly technical, our belief was that even complicated subjects could be rendered in such a way as to make them comprehensible to a wide audience. In the same way that an electrical engineer might need explanations when encountering genetic terminology, students and non-specialists will also appreciate the clarification. Because of the pervasiveness of the subjects in all facets of our lives, the encyclopedia should be a handy reference tool for a broad range of readers. Our aim was to make the subjects, which many of us deal with daily and do not necessarily grasp completely, readily understood with a minimum need for additional reference. However, should the reader wish to delve further into any particular subject, our expert authors have provided a selection of further bibliographic readings with which to begin.

The scope of the encyclopedia is intended to be international. Discussions were to be as inclusive as possible and avoid focus solely on the events of any one country. Nonetheless, some skewing was unavoidable due simply to the prodigious number of developments that have taken place in some countries.

**William E. Worthington, Jr.**



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