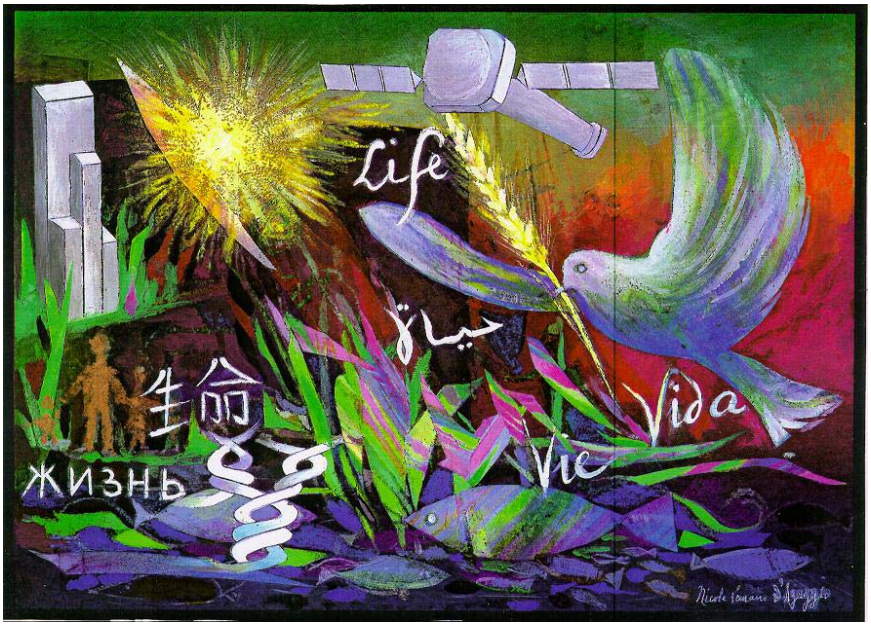
ENCYCLOPEDIA OF LIFE SUPPORT SYSTEMS

Conceptual Framework



A life support system is any natural or human engineered system that furthers the life of the biosphere in a sustainable fashion. The fundamental attribute of life support systems is that together they provide all of the sustainable needs required for continuance of life.

29-09-2011

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ENCYCLOPEDIA OF LIFE SUPPORT SYSTEMS

A source of knowledge for sustainable development and global security to lead to fulfilment of human needs through simultaneous socio-economic and technological progress and conservation of the Earth's natural systems.

Conceptual Framework

(A document intended to provide a conceptual framework for participants in the EOLSS project. In particular, authors are directed to the subject matter coverage requirements that are likely to meet the needs of different groups of EOLSS users. The objective is to ensure that the aim of all participants' efforts is consistent with the global nature of the EOLSS mission.)

"Pursuit of knowledge and truth supersedes present considerations of what nature, life or the world are or should be, for our own vision can only be a narrow one. Ethical evaluation and rules of justice have changed and will change over time and will have to adapt. Law is made for man, not man for law. If it does not fit any more, change it. Some think that it is being arrogant to try to modify nature; arrogance is to claim that we are perfect as we are! With all the caution that must be exercised and despite the risks that will be encountered, carefully pondering each step, mankind must and will continue along its path, for we have no right to switch off the lights of the future. We have to walk the path FROM THE TREE OF KNOWLEDGE TO THE CONTROL OF DESTINY."

Jean-Marie Lehn, Nobel Prize in Chemistry

"EOLSS is concerned with the Life Support Systems: Water, Energy, Environment, Food and Agriculture. Each of these systems is a very complex one. …. we have to think of all these "systems" as closely related "subsystems" of the Planet Earth System. The situation is extremely different in most of life support systems modeling…. the results are not needed with the same degree of precision …. but they should be robust (and valid) for very different time horizons. There is not one model, but a hierarchy of models. Examples of these situations will be given throughout the Encyclopedia. …. More delicate are the global problems, involving several goals, with possible conflicts of interest. ….Rational decisions will be more and more possible to envision if one will be able to couple the physical modeling to economic and financial models and to human factors …. These delicate and fundamental questions will deserve a lot of attention in the Encyclopedia."

J. L. Lions *Japan Prize Recipient in Applied Mathematics*

"The population of our planet and its development over the ages sets the scene for considering all global problems and it is reasonable to begin their discussion with population growth. **….** *Thus we are dealing with an interdisciplinary problem in an attempt to describe the total human experience, right from its very beginning. But without this perspective of time it is not possible to objectively assess what is happening today and provide an objective view of the present state of development, the challenge now facing humanity.* **….** *Of other global problems energy will be considered most. Energy in all its forms is the main factor determining the production of food, support of industry and transportation, the general well-being of humans and the security of societies."*

S. P. Kapitza, UNESCO Kalinga Laureate

"Scientific curiosity and technological endeavors are deeply rooted aspects of human nature. They are responsible for the development of human society and welfare. But they are also responsible for much of the environmental problems we are facing today. Solutions for these shortcomings are inconceivable without full scientific and technological support. EOLSS has the goal to provide a firm knowledge base for future activities to prolong the lifetime of the human race in a hospitable environment."

Richard R. Ernst *Nobel Laureate- Chemistry*

"------ the EOLSS is not only appropriate, but it is imaginative and, to my knowledge, unique. Much of what we can write about science, about energy, about our far-ranging knowledge base, can indeed be found in major encyclopedias, but as I understand your vision, never as a central theme; the theme of humanity, embedded in nature and constrained to find ways of maintaining a relationship with nature based upon understanding and respect."

Leon M. Lederman, Nobel Prize in Physics

"Ecotechnology involving appropriate blends of traditional technologies and the ecological prudence of the past with frontier technologies such as biotechnology, information technology, space technology, new materials, renewable energy technology and management technology, can help us to promote global sustainable development involving harmony between humankind and nature on the one hand and tolerance and love of diversity and pluralism in human societies on the other. We need shifts in technology and public policy. This is a challenging task to which the Encyclopedia of Life Support Systems should address itself."

M. S. Swaminathan, First World Food Prize

EOLSS MISSION

"The Encyclopedia of Life Support Systems (EOLSS) presents a comprehensive, authoritative, and integrated body of knowledge of life support systems. It is a forward-looking publication, designed as a global guide to professional practice, education, and heightened social awareness of critical life support issues. The EOLSS is developed as a dependable source of knowledge for use in human endeavors aimed at development of remedial measures to counter the current practices, which imperil the Earth's essential life support systems. Natural and social sciences, humanities, engineering and technology, and management policies for sustainable use of life support systems are emphasized, together with issues of global change and their ecological, economic, social, ethical, cultural, and political dimensions. The EOLSS is intended to enhance the systematic development of knowledge that is essential for global stability, security, and peace. In particular, the EOLSS presents perspectives from worldwide regions and cultures, and is free from geographic, racial, cultural, political, gender, age, or religious bias."

DEFINITION OF 'LIFE SUPPORT SYSTEMS' IN THE CONTEXT OF THE EOLSS

A life support system is any natural or human-engineered system that furthers the life of the biosphere in a sustainable fashion. The fundamental attribute of life support systems is that together they provide all of the needs required for continuance of life. These needs go far beyond biological requirements. Thus, life support systems encompass natural environmental systems as well as ancillary social systems required to foster societal harmony, safety, nutrition, medical care, economic standards, development of new technology, etc.. The one common thread in all of these systems is that they operate in partnership with the conservation of global natural resources.

GLOBAL CRISISAND SUSTAINABLE DEVELOPMENT: THE INSPIRATION FOR THE EOLSS

At present, as never before, the future of life on our planet has become a matter of great concern. As the twenty-first century and the third millennium approach, we are confronted with several warnings concerning the growing fragility of the Earth's life support systems. For example, on November 18, 1992, some of the world's senior scientists from 70 countries, including 102 of the living scientists who are Nobel Laureates, signed and sent an urgent warning to government leaders of all nations as part of the United Nations Conference on Environment and Development (the "Earth Summit") held in Rio de Janeiro, Brazil. According to this warning:

"The environment is suffering critical stress…. Our massive tampering with the world's interdependent web of life – coupled with the environmental damage which is inflicted by deforestation, species loss, and climate change – could trigger widespread adverse effects, including unpredictable collapses of critical biological systems whose interactions and dynamics we only imperfectly understand. Uncertainty over the extent of these effects cannot excuse complacency or delay in facing the threats.
"No more than one or a few decades remain before the chance to avert the threats we now confront will be lost and the prospects for humanity immeasurably diminished….
"A great change in the stewardship of the Earth and the life on it is required, if vast human misery is to be avoided and our global home on this planet is not to be irretrievably mutilated…. Acting on this recognition is not altruism, but enlightened self interest. Whether industrialized or not, we all

have one lifeboat. No nation can escape injury when global biological systems are damaged. No nations can escape from conflicts over increasingly scarce resources. In addition, environmental and economic instabilities will cause mass migrations with incalculable consequences for developed and underdeveloped nations alike….

> *"A new ethic is required – a new responsibility for caring for ourselves and for the Earth. We must recognise the Earth's limited capacity to provide for us…. We must no longer allow it to be ravaged. This ethic must motivate a great movement, convincing reluctant leaders and reluctant governments and reluctant peoples themselves to effect the needed changes."*

The Talloires Declaration of October 1990, by the Association of University Leaders for a Sustainable Future, was a significant forerunner to the Earth Summit held in Rio de Janeiro in 1992. The declaration of the latter, endorsed by governments of most of the world's nation states, was the most prominent among the many documents that highlight the impending crisis. The Rio summit was followed by several other events which include: the Global Conference on Sustainable Development of Small Island Developing States, Barbados, 1994; the International Conference on Population and Development, Cairo, 1994; the World Summit on Social Development, Copenhagen, 1995; the Fourth World Conference on Women, Beijing, 1995; the Second UN Conference on Human Settlements, Habitat II, Istanbul, 1996; and other non-UN forums. All these, and many other events, have raised awareness and contributed to the concept of sustainable development.

It will be useful to recall ***Agenda*** 21 of the Earth Summit. The first part of Section 5.3 of the document says:

> *"The growth of world population and production combined with unsustainable consumption patterns places increasingly severe stress on the 'life supporting' capacities of our planet. These interactive processes affect the use of land, water, air, energy, and other resources."*

When discussing "life support systems", the authors of this document specified concern for the wise use of land, water, air, energy, and other resources. These resources underpin life itself. However, life is a highly complex set of interactive systems on which human existence is ultimately dependent. The collapse of some ocean fisheries, the destructive influence of agricultural and animal husbandry practices on unsuitable lands, and the devastation of tropical rain forests are all caused, directly or indirectly, by population growth pressure. These practices seriously threaten sustainability and, ultimately, human survival.

The EOLSS represents a significant response to the grave concerns expressed at these conferences. It is a concerted global intellectual effort of unprecedented magnitude towards developing a knowledge base, which presents systemic approaches for the development of life support systems that constructively respond to the needs for sustainability and **global stability and peace**.

Economic and development policies should be oriented as needed, to respect the earth's carrying capacity. In this way human actions are guided to avoid conflicts between these policies and the Earth's natural systems, which might lead to "global crisis" Instead, the policies should ensure the maintenance of conditions for sustainability of life and global security. The notions of global (international) security and risk have not been defined precisely and uniformly enough thus far, primarily because they involve threats and opportunities that have not been fully realized. Until recently, international security was considered synonymous with military security, although it is clear that this is an inadequate definition. There are in fact at least seven different types of human security, namely, ***Economic, Food, Health, Environmental, Personal, Community, and Political****. The threats to security are also varied and can be military, economic, social, or ecological.*

A major premise motivating the evolution of the Enclopedia is that economic and other development policies should be based on the principles of sustainability, namely: intergenerational equity; intragenerational equity, and precautionary principle (risk aversion strategies) and conservation of biodiversity In this respect, several knowledge resources are essential for an integrated and comprehensive understanding of the sustainable development paradigm. Naturally, scholars from

diverse fields of specialization tend to use different nomenclature to characterize this knowledge. However, the following broad framework has received wide acceptance:

Natural Resources or Natural Capital (The Environmental Dimension)
Economic Resources or Built Capital (The Economic Dimension)
Social Resources or Social Capital (The Social Dimension)
Institutional Resources or Institutional Capital (The Institutional Dimension)

The complex interactions among the various subsystems are shown in Figures 1(a) and 1(b). Figure 1(a) shows the various fundamental dimensions of the sustainable development paradigm which relies on a wide spectrum of disciplines. Figure 1(b) suggests what has to be sustained by human policies aimed at better quality of life.

Other ways of subdividing the total system are possible. In order for the total system (the human system embedded in the natural system) to be viable, each of these essential subsystems must be viable. Viability of the total system depends on the proper functioning of the sub-systems. The six subsystems correspond to potentials that must be sustainably maintained. Although other classifications are possible, this identification of subsystems is not arbitrary.

The knowledge needed for the understanding of the subsystems for their sustainability is highly interdisciplinary. For instance, to understand the sustainability of the Natural Capital (or Environmental Dimension), one has to rely on disciplines such as Biology, Physics, Chemistry, Geology, as well as Mathematical Sciences in addition to the use of technological tools such as Computer Systems, Remote Sensing, Global Information Systems, etc. as depicted for the sake of simplicity in Figure 1(c).

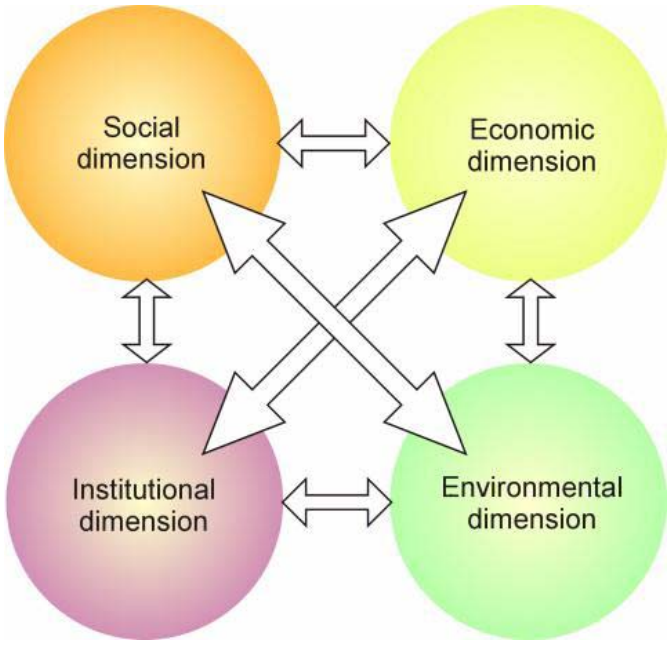

Figure 1(a): The complex interactions among the different dimensions of sustainable development

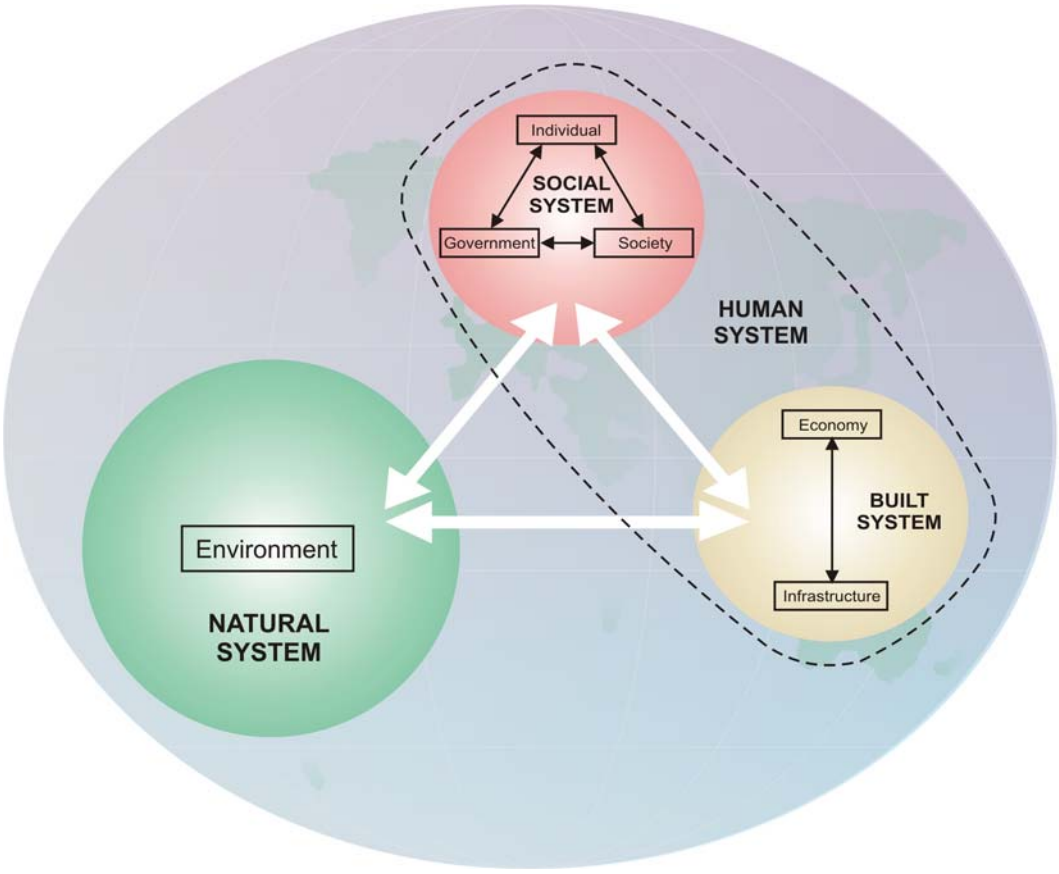

Figure 1(b): The six major systems of the anthroposphere and their major relationships. These six sector systems can be aggregated to the three subsystems: Human system, Built system and Natural system.

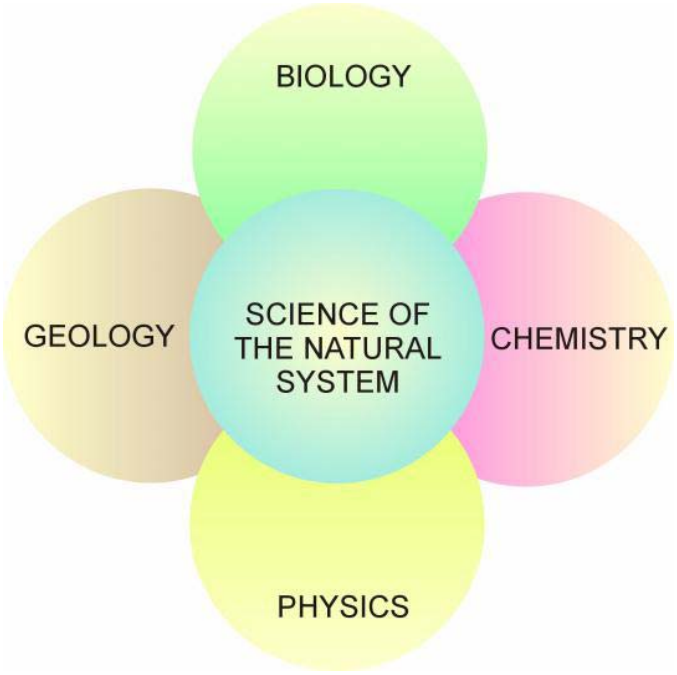

Figure 1(c): An understanding of the sustainability of the natural system lies at the confluence of many disciplines.

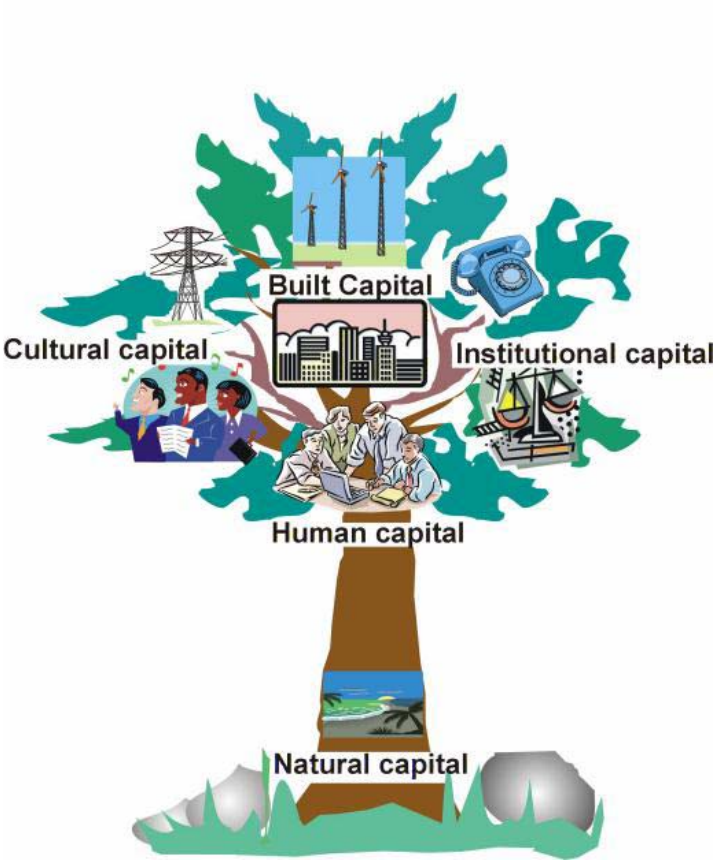

Figure 1(d): Sustainable Development with reference to Different forms of Capital

Figure 1(d) shows that the body of knowledge may be referred to different forms of capital that are essential for global stability, security, and peace.

The contributions in the EOLSS present the origins of current life support systems and discuss threats to them. The authors present up-to-date scenarios, including the state-of-the-art and latest advance in relevant technologies, with predictions and recommendations regarding future trends. There are four time-scales and approaches associated with these systems (Figure 2). This figure may also be regarded as a maturity model for sustainable development.

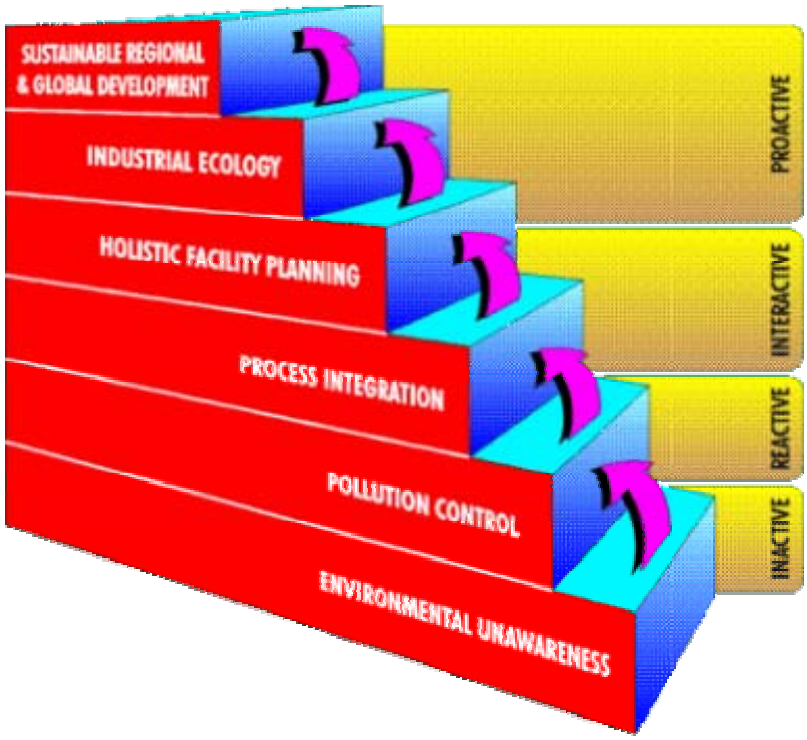

Figure 2: Towards Sustainable Development - A Maturity Model

The far past is associated with inactive approaches in which there is no concern for environmental degradation and sustainability.

The time-scale of the immediate past is concerned primarily with reactive approaches. It involves prevention oriented remedies and strategies for coping with improper disposal of industrial wastes and environmental degradation due to the acquisition of environmentally inappropriate products and practices.

The time-scale of the present is associated with interactive approaches and is concerned with regulations and standards that ameliorate the harmful effects of those processes which might otherwise result in the creation of harmful products and services.

The time-scale of the future is concerned with proactive approaches that prevent the degradation of the Earth, respect the Earth's carrying capacity and assure sustainability of essential resources, processes, and products through the engineering, and reengineering, of production processes and of organizations. A proactive approach to sustainable development would also include interactive and reactive components. Tragedies and crises will occur, despite efforts to prevent them, and reactive techniques may often be the only way to diagnose and remedy such situations. To achieve these aims requires a broad understanding of many scientific disciplines and technologies, and their interactions leading to an integrated knowledge base for the sustainability of the world resources in their broadest sense.

FEATURES OF THE EOLSS

There is a growing need for a knowledge source that presents authoritative, comprehensive, and integrated approaches to the science, technology, and management of natural and human resources necessary for life support. The use of essential natural resources or natural environment capital must be orchestrated and enhanced through human engineering efforts to ensure that the resulting resources are ecologically sustainable. The EOLSS is being developed to meet these needs. The EOLSS is designed to:
Contain a thematic presentation of knowledge in a manner that will be helpful for the development of initial, as well as long term, understanding of relevant multidisciplinary aspects of life support systems.
Include comprehensive coverage of the subject matter, from its origin to the present state-of-the-art with discussions of significant contemporary advances and future perspectives.
Provide a lucid, pedagogical, and authoritative presentation of data, information, and knowledge that will be of value for scientific, engineering, management, and policy making purposes in these areas, as well as for technology transfer across nations and regions of the world with broadly divergent social and cultural outlooks.

Present a detailed description and analysis of essential life support systems.

Discuss sustainable development and global security issues as they apply to essential life support systems.
Elucidate the knowledge foundations needed for development of these resources in such a way that they are suitable for self study, through presentations of overview and specific contributions in each Subject Domains

The EOLSS is intended to be especially useful for those with diverse needs in Natural and Social Sciences, Humanities, Technology, Engineering, Systems Management, and Policy Analysis.

NOTION OF AN ENCYCLOPEDIA

An encyclopedia is an alphabetically or thematically structured collection of contributions from all branches of an art, a technology, or some combination of these that provides a comprehensive treatment of the intended subject. Ideally, an encyclopedia should appeal to a broad range of readership, providing them with the equivalent of consulting an expert in a given domain.
It should serve as the first place of search by the specialist or the non-specialist looking for information on a subject related to their own expertise. Library and information scientists may use it as a preliminary reference for research into a specialist field. Managers and policy makers may refer to it in deciding the use of a particular technology or strategy. Alternatively, it could be used by practicing professionals searching for a specific detail, or students trying to gain an overview of the essentials of a subject. The EOLSS addresses the needs of all these readers.
Knowledge presented in its pages focuses on the principles and practices that have been shown to be of value in the evolution of sustainable life support systems.

The Encyclopedia is designed provide comprehensive data, information, and knowledge concerning contemporary life support issues of Global Sustainable Development, essential life support systems, and an integration of the knowledge base of , Natural and Social Sciences, Engineering and Technology, and Humanities referred to here as Knowledge Foundations.

The EOLSS is expected to provide an appropriate knowledge base, enriched with ethics and cultural perspectives of all parts of the globe, to inspire: nations, governments, leaders, and the peoples. The contributions to the encyclopedia come from a broad spectrum of well-known experts from leading academic and research institutions, professional organizations, legislative government agencies, private enterprises, and policy planning bodies throughout the world.

The EOLSS is designed to appeal to a wide spectrum of users – from the merely curious to those seeking in-depth knowledge. To satisfy these, the EOLSS Contents have the following characteristics:

Popular appeal - by providing widely understandable perspective presentations.
Educational relevance - through presentations that emphasize knowledge principles, or fundamentals, and their applications.
Professional utility - through descriptions of knowledge practices and their applications.
Research relevance - through presentation of knowledge principles that are of general value to specialists who wish to undertake study in related subjects.
Future and policy orientation - through provision of knowledge perspectives that are useful for obtaining forecasts of trends in science, technology, and social programs.

The Inaugural Edition of the EOLSS will be launched on the World Wide Web in December 2001. This will grow to about 70 million words through regular uploads and will be an on-line Living Encyclopedia.

There are five major target audiences for the EOLSS:

University/College students (undergraduates and graduates) who wish to introduce themselves to a particular subject in the life support systems either by self study or formal lecture participation.
Educators interested in the subject areas of the EOLSS and who may wish to prepare a comprehensive coverage of these subjects for lecture and seminar presentations.
Professional practitioners and informed specialists who wish to refresh and update their knowledge, and to relate their knowledge to applications and subjects transcending their own specialization.
Research personnel who wish to inform themselves about innovations and new approaches to problem solving.
Policy analysts, managers, and decision makers in the public and private sectors, including development officials and non-governmental organizations, who wish to equip themselves with the technical and systems management knowledge required to better incorporate science and technology in their decision-making.

The EOLSS is intended to be the literary equivalent of an expert advisor, a sophisticated expert system, which can be used to summarize the state-of-the-art in subject domains, identify formal knowledge principles, relevant knowledge practices and likely future perspectives, and suggest additional sources of relevant material. In this way, the EOLSS may be regarded as a source of carefully organized knowledge and not just a provider of raw information and data.

DEVELOPMENT OF THE EOLSS BODY OF KNOWLEDGE

In early May 1996, 450 scientists, engineers, and policy makers from many countries were invited to the Bahamas to participate in defining the EOLSS body of knowledge. The Bahamas Workshop was the culmination of international collaborative efforts to generate a detailed list of contents and achieve a global consensus and acceptance of its structure.
The Bahamas Workshop followed several smaller workshops that had been held earlier in 1996: in Washington DC (January 25–28), Tokyo (March 7–8), Moscow (March 13–15), Mexico City (March 28–29), and Beijing (March 29–31). In addition, a team of scientists from the French Academy of Sciences provided an assessment and recommendations. These earlier meetings and the Bahamas Workshop were devoted not only to the overall philosophy and scope of the EOLSS, but also to identifying in-depth coverage of specific issues.

The results from Bahamas workshop were reviewed by invited specialist teams of experts in USA, Japan, Russia and China in collaboration with additional meetings: August 1996 Panama, Regional Committee for South and Central America; September 1996 Abu Sultan, Egypt Regional Committee for Africa and the Middle East; March 1997 Kuala Lumpur, Asian Regional Committee, to complete and unify the list of contents.

The EOLSS House of knowledge is shown in Figure 3. The body of knowledge has been defined in terms units called Themes. The hierarchy of contributions themes is shown in Figure 4. There are a few exceptions: themes under Regional Reviews extend only to the Topic Level. A theme has three distinctive levels of writings: Theme Level, Topic Level and Article Level, with an increasing depth of specialization. Each theme with its Topics and Articles may be regarded as a collection of about thirty Chapters. The full text of the EOLSS Body of Knowledge, comprising about 200 themes, and has been developed under the expertise of Honorary Theme Editors (HTEs). The contributions come from over 6000 authors from over 100 countries.

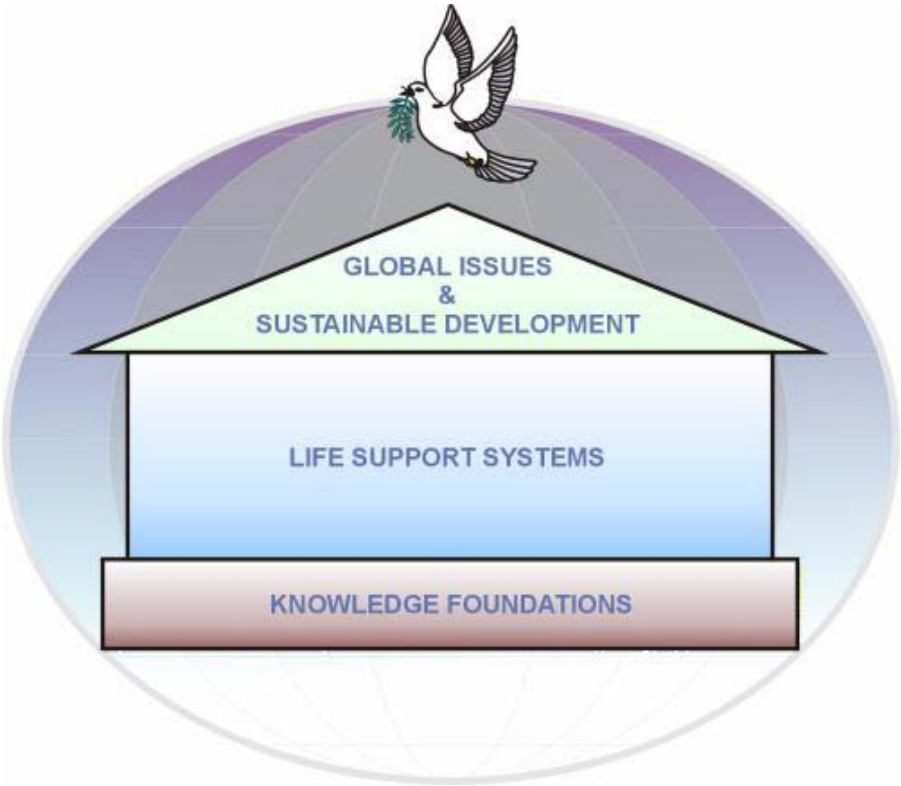

Figure 3. EOLSS House of Knowledge

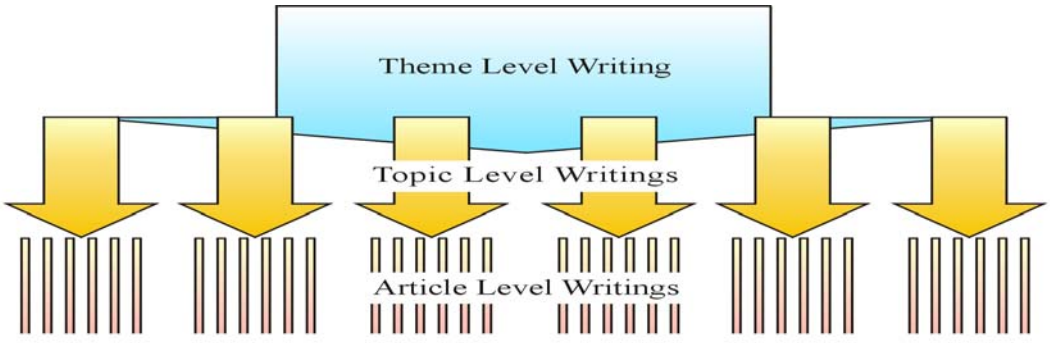

Figure 4: Hierarchical structure of the EOLSS body of knowledge

EOLSS CONTRIBUTIONS

EOLSS Contributions are written at different levels of hierarchy:
Theme Level Writings
Topic Level Writings
Article Level Writings

Theme-level Writings

These contributions establish the scope of the Topics that will follow. Theme-level contributions are not intended to offer in-depth analysis of the micro-level details of a particular subject, but rather to integrate all aspects of the Topics that fit within a particular Theme. Theme-level contributions may include broad historical perspectives, foundations of science, technology, and policy; and professional practice and future-oriented (towards sustainable world development) coverage in the respective Topics and Articles within the Theme as they relate to sustainable development. Surveys of the state of the art form part of the contributions at this level, exposing the reader to current and future trends. The length of these contributions is in the region of 15 000 to 20 000 words.

Topic-level Writings

Topic-level contributions provide a broad summary and evaluation of the subjects to be covered by a group of Articles. Contributions at the Topic level include detailed historical perspectives, foundations of science, technology, and policy; and professional practice and related discussions. Topic-level contributions provide in-depth summaries and indicate where progress is being made in the field. Where appropriate, future- and policy- oriented coverage (towards sustainable world development) are highlighted in the form of a concluding section to the Topic level contributions. The contributions are accessible to advanced students who want to begin or advance their knowledge in a particular subject. The length of Topic-level contributions is in the region of 10 000 to 15 000 words.

Article-level Writings

Most of the contributions in the EOLSS are at the Article level. Articles cover a subject in depth and contain relevant and necessary details of the established knowledge associated with it. Although Articles present an increased depth of knowledge not found in the higher-level contributions, to be of value to the various target audiences they are structured so as to appeal to both the non-specialist and the expert in related fields who seek a comprehensive understanding of efforts in the subject of the article. To achieve this objective, Articles have a self-contained introduction that presents background information allowing the reader – whether student, practitioner or researcher, – to gain a relatively complete picture without the need to delve

further into the Article for detailed discussions. The main part of the Article then describes the state of the art of the subject treated, in an increasing degree of detail, and tells an expert in a related field what they need to know about the subject of the Article. Because the EOLSS is forward looking, into the far future, authors have been encouraged to include their thoughts on future trends and perspectives that relate to their subject. Such material will be of interest to all types of readership, not least to policy makers and forecasters of science and technology trends. In-depth presentation of historical aspects, foundations of science, technology, and policy; and professional practice aspects are desired in Article level contributions. Future directions for further in depth studies are highlighted in the form of a concluding section to the Article. Articles contain the latest advances and results in the subject. Relevant examples, such as brief case studies, are also included, as well as appropriate economic estimates. Articles do not generally contain detailed derivations of well-established fundamentals when these can be found in appropriate portions of Knowledge Foundations. The length of Articles is generally in the region of 5,000 - 10,000 words.

A Theme has therefore three distinctive levels of writings; Theme Level, Topic level and Article Level, with an increasing depth of specialization. Each Theme with its Topics and Articles may be regarded as a collection of about thirty chapters.

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The EOLSS International Editorial Council was established thus: Board of General Advisors (BGA), Honorary Editorial Advisory Board (HEAB), and Honorary Academic Editorial Board (HAEB) as a large editorial advisory body with several hundreds of expert members chosen to advice on the development of the Encyclopedia. The Configuration Control Board is a high-level body with membership chosen from the International Editorial Council (IEC). Several individuals advised and contributed to the development of the EOLSS Body of Knowledge through meetings, discussions and communications. The list is given below with apologies for any inadvertent omissions

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