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Distr. : LIMITED
E/ESCWA/TECH/1995/WG.1/2
30 August 1995
ORIGINAL : ENGLISH

UNITED NATIONS
ECONOMIC AND SOCIAL COUNCIL

Economic and Social Commission for Western Asia

Expert Group Meeting on Revitalization of Research and Development Activities in the ESCWA Countries
12 to 14 September 1995
Hurghada, Egypt

R&D Revitalization in the Scientific Studies and Research Centre and in the Higher Institute of Applied Sciences and Technology in the Syrian Arab Republic

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UN ECONOMIC AND SOCIAL COMMISSION
FOR WESTERN ASIA
9 - NOV 1995
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Co-sponsor : United Nations Industrial Development Organization (UNIDO)

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95-0371

The R&D Revitalization Process at the Syrian Scientific Studies and Research Center Viewed within the Context of Global Trends and Developing Country Perspectives

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Introduction

The difficulties and challenges that confront economic growth and social development in countries of the ESCWA region are many and varied. A major underlying cause may be found in the relatively low productivity and output (as well as output quality) of the various sectors that constitute the national economies of these countries . These are in general considerably inferior to those associated with comparable sectors in developed countries and newly industrialized countries.

This state of affairs appears to be endemic and is characteristic of a majority of developing countries as they attempt to face up to the challenge of development.

It is necessary to restate at this point what has become a platitude, namely that today's developed and growing economies are science and technology driven. These are not sufficient instruments in themselves to achieve economic and social development, since they need to be coupled with other elements, but in this modern age they are certainly crucial instruments for development.

Modern theories of development economics increasingly ascribe the potential for sectorial and enterprise growth and development to the appropriate, effective and sustained application of scientific and technological inputs, resulting in sustained innovation in products, processes and services. This must surely stand out as one of the overriding themes in modern development, despite the fact that it tends to oversimplify a broad range of highly complex issues and processes, some of which will be addressed subsequently.

Three central requirements among others need to be met in order to achieve successful and sustained infusion of scientific and technological inputs into the respective economic sectors. The first is the existence of a well developed and effective S&T system within the national economy; and the second is the existence of effective linkages between the S&T system and the productive sectors; the third is the existence of technical innovation capability and practice within the productive sectors per se. Serious deficiencies exist on all three counts in countries of the ESCWA region. A clearer understanding of the causes for these failures is presently emerging.

National research institutes established in the 60's, 70's and 80's were expected to play an important role in promoting national development through the conduct of R&D activities and programs. These were intended to emulate comparable institutions already existing or set up in developed countries in the 50's and 60's. The major underlying assumptions were that technology based development was predominantly science and technology pushed . It is now evident in retrospect that this was a very simplistic, if not naive assumption. This view however also pervaded centers of R&D excellence in the developed economies throughout the 50's, 60's and part of the 70's , and it constituted a central element of the science and technology legacy of the times.

The industrial technology-based growth patterns which emerged in the 70's and 80's in the Far East and which represented major competitive challenges to previously dominant Western industries promoted major rethinking of long-held views and concepts related to science and technology based innovation. The classical linear view of this process was called into question as more complex, multi-dimensional, multipath routes to innovation were being demonstrated. This necessitated a rethinking of the objectives, roles, activities, strategies, and downstream linkages of government laboratories and other research institutes in developed countries with a view towards revitalizing them in order that they may play a more effective role in the innovation chain, and to be more responsive to market needs.

This process has been underway for some time in developed countries and has so far only partially achieved its objectives, In developing countries in general and in countries of the ESCWA region in particular, many R&D institutes still cling to the old inherited patterns, while others have begun to sense the need for change. Fewer still have begun planning for and actually implementing change. There are many reasons behind what may prove to be a slow and arduous process.

Above all there needs to be a clearer and in-depth appreciation of the issues and considerations that necessitate change . Many of these relate to evolving global patterns and trends connected with business, technology and markets. Others are institution oriented and relate to the enterprises (public and private) which are the focal point of national economic activity and the ultimate beneficiaries of national S&T activities, and to the research institutes themselves as elements within the national S&T system or more broadly, what has come to be termed the national system of innovation.

Part I of this study essentially addresses the global context. Important global evolving patterns and trends as they affect business, technologies and markets will be addressed . In an increasingly interlinked global economy, such issues provide the basic setting for determining both the nature and direction of change that needs to be introduced in the national S&T system and in particular in national S&T institutes.

The changing perspectives relating to the roles, missions and activities of national R&D institutes will then be addressed,followed by an investigation of evolving views related to R&D, innovation, and commercialization. Broad implications are then derived for national S&T and innovation policies and strategies.

Part II focuses on developing countries and, by implication, ESCWA countries, with emphasis on S&T and innovation policy and strategy challenges confronting them in the context of the current techno-economic paradigm.

Part III addresses the evolution of SSRC, the process of R&D revitalization that has accompanied its evolution, and future thrusts and challenges. A separate paper specifically addresses the Higher Institute for Applied Sciences and Technology (HIAST) whose establishment was promoted by SSRC. The paper, prepared by the Director of HIAST, clearly indicates that HIAST is getting poised for a growing role in supporting national development, both through the provision of qualified manpower as well as through participation in the Syrian technology based development process.

I. Global Trends and Their Implications

I.1 The Pervasive Impact of the Electronics/Informatics/Communications Techno-Economic Paradigm

The global economy in general and entire ranges of products, processes and services are presently under the profound impact of what has been termed the electronics/informatics/communications techno-economic paradigm. Major characteristics of this paradigm are its flexibility and pervasiveness. In recent decades these have enabled the growth of new high-tech industries and services, while at the same time enhancing traditional ones.

This new paradigm is technology driven, knowledge intensive and highly dynamic and has brought about major changes in the previously prevailing environment relating to business, R&D and innovation,and to markets and competition. It has also accentuated the need for stronger linkages between these various elements and for a greater integration of the corresponding strategies applied at the national level or at the sectorial and enterprise/institution levels.

I.2 Changes in the Business and Market Environments

Since 1980 there has been increasing evidence of a discontinuous change in the business environment. A set of compelling and even dominant trends are visible in numerous markets, from consumer products to industrial equipment to components.These are[1]:

Shorter product life cycles (particularly in high-technology markets); greater product diversity, variety and complexity; fragmented markets; widespread alternatives; vastly more rigorous standards (related to quality, serviceability, reliability); sophisticated customers.

The above trends have largely been propelled by the new techno-economic paradigm. Thus scientific and technical knowledge associated with it has allowed the development of highly complex production processes and has expanded product features and variety. The proliferation of technical knowledge and diverse equipment on a global scale has opened up the market for greater competition and has allowed for the growth of businesses around ever-smaller fragmented market segments(niches).These and related trends have created a compelling need for enterprises to integrate their business and technical strategies.

Furthermore the above trends interact and reinforce one another, to militate against the mass-production strategies typical of the past in preference for more flexible customer oriented responses. The economy-of-scale logic that dominated in the past is thus being transformed to an economy-of-scope logic.

Further significiant global trends relate to the move towards pollution free products and processes which carry implications for future competition. On a broader level, business world-wide is being subject to increased pressure for deregulation and privatization. At the same time it is expected to conform to the regulatory procedures being imposed by the newly established World Trade Organization, e.g. the application of quality standards such as ISO 9000 .

I.3 Changes in the Competitive Environment : The New Competition

Closely related to the changing business environment are the major changes taking place in the competitive environment, whose primary characteristics are as follows:

* The increasing global orientation of competition which has also triggered increasingly visible trends towards external cooperation, global strategic and value-added partnerships [2].

* New opportunities for a larger number of competitors due to market segmentation and fragmentation trends across a broadening range of sectors.

* Enterprise competition will be increasingly prominent in determining national futures. This competition is largely rooted in technology based innovation applied to products, processes and services. The adoption of appropriate innovation strategies is thus essential for many companies faced with current market conditions [3,4].

* Survival in the new environment demands that local firms match regional,national and international competitors on key standards of

cost, quality, servicability, innovation and value to customer [1].

*Although competition occurs at the enterprise level,government plays a critical role in this process.Education, S&T policy, R&D financing, tax and labor legislation, transportation, infrastructure, energy and communications, are examples of vital components of competitiveness determined on the national level by government [3].

*International competitiveness is achieved within the context of a national economy and describes the capacity of a nation to sustain or increase the participation of its goods and services in international markets [3].

I.4 The Changing Role and Impact of Technology and Related Trends

During the 80's technology as a strategic factor became so widely acknowledged as to cause firms and even countries to realize that financial, marketing and technological considerations needed to be integrated in overall strategy development. The following technology related trends are particularly discernible:

*Industrial competitiveness has become increasingly technology-based with success hinging on coping with challenges related to the management of technology, including [5]:

- .How to get into and out of technologies faster and more efficiently.
- .How best to accomplish technology acquisition and transfer, particularly for increasingly sophisticated technologies.
- .How to manage the enterprise's internal use of technology.
- .How to manage the strategic integration of internal and external sources for technological development.

*Recent technological advances are contributing to changes in industrial productivity and costs, impacting on global and national structures of production, trade and employment [6].

*Increasingly, the value of a product is being determined by the technology that goes into it, and not by the raw material that constitutes it [6].

*Strong competition from rivals and increased openness of the market have raised the imperative for continued technological innovation. The most important strategic consideration has thus become the management of technological innovation faster than others [6].

*New technologies are becoming increasingly multi-disciplinary. This orientation for example is evident in new manufacturing technologies, which are driven by trends in materials science, control theory, artificial intelligence,combined with application of computers, communication technology and information science techniques [1].

*For a widening range of industries at the international technological frontier, investment in new knowledge assets is coming to exceed investment in physical assets as a major source of competitveness.

*There is a growing need to understand and to diffuse understanding of these new trends which also carry implications for how to best educate future engineers and technologists. Necessary shifts in classical single-discipline education need to be made towards a multi-disciplinary emphasis. Technological multi-disciplinarity also carries implications for how to build S & T structures and institutions and how to manage the related R&D processes.

I.5 Organizational and Cultural Change within Institutions and Enterprises

Successful innovation and technological progress in the evolving global paradigm have created imperatives for fundamental change in the management, organization and culture of institutions and enterprises, and the manner in which they relate to, and interact with, each other. Among the key evolving trends are the following:

*Organizations ,particularly those involved in high technology, must respond to rapid change in their environment with frequent change in strategy and direction [7].

*Excessive specialization and hierarchy can become obstacles to technical innovation. More open horizontal management styles are proving to be far more effective for sustained innovation [4].

*New flexible organizational structures are required with emphasis on organic rather than mechanistic methods of operation [2].

*There is a marked shift towards functional integration within enterprises and institutions, as well as towards strategic integration between firms and institutions through value-added partnerships [1].

*The new paradigm is not the fully automated plant, but a management system which creates a process that continuously absorbs incremental or secondary innovations leading to higher levels of efficiency and competitiveness. Within such a system, technology per se is not the decisive factor; intangible investments, ranging from basic technical skills to highly qualified engineering know-how and sophisticated marketing abilities, play a crucial role [8].

I.6 Changing Perspectives Relating to the Roles, Missions and Activities of National R&D Institutes

In recent years national R&D institutes world-wide have been subjected to greater scrutiny, with serious questions being raised about their effectiveness and their actual impact on technology-based national development.

Since revitalization of R&D institutes is the main theme of this study, a closer investigation of the essential underlying issues is presented in what follows.

The scrutiny of such institutions has taken place at many levels, including:

1-The positioning of these institutes within the national S&T system and their interrelationship with its various elements.

2-Their structure.

3-Their missions,orientations, and activities.

4-The degree of coupling with downstream engineering, production and marketing.

5-Their output, particularly with regard to their impact on national innovation activity in products, processes and services.

I.6.1 Government Supported Science and Technology: A Historical Perspective:

Gilmour has identified four historical phases of government supported science and technology characterized as follows [9]:

1-Beginnings(1860-1945) : There was much hope and optimism that supply side science will find its beneficial application.

2-A Golden Age of Faith(1945-1965/70): A huge expansion and extension of the supply driven model took place.

3-An Era of Doubts(1965/70-1990) : Questions and second thoughts were being raised,as well as experimentation with alternate models.

4-Emergence, universal acceptance and application of a new model(1990-2010): The model is demand directed and focused on technology diffusion.

The above trends clearly reflect a progressive disillusionment with supply side government S&T. Nevertheless many government S&T institutions, reared in the earlier modes and patterns, find difficulty in effecting the required paradigm shift. This is particularly true of most government S&T institutions in developing countries.

While the old model may have been valid in the earlier historical context within which it evolved, it has become increasingly out of step with the dynamism and complexity of the present technological era which is increasingly driven by commercial and market requirements.

The growing criticisms leveled at Canadian public sector S&T

institutions and R&D programs in the 70's and 80's, for example, included the following [9]:

*Government S&T institutions operated and were being evaluated within the ethos of the research community rather than the ethos of end-users of the research results.

*Research produced in Federal R&D programs in Canada on industry's behalf was seldom used by the industry in question because industry was seldom asked whether or not it needed it .

*Most industry spokesmen interviewed believed overwhelmingly that most industry-oriented research conducted by government was close to useless. Not enough of it was of a practical nature, or related to specific industrial problems.

*Most government laboratories did not possess the right philosophy required for assisting commercial organizations, and most individuals in government laboratories had the wrong attitudes which were not suitable for helping industry.

Similar criticisms have been leveled at U.S. Federal S&T systems and R&D programs . Central to the current U.S. discourse on Federal R&D is a growing perception that the design concepts, processes and institutions associated with the current system assure an ineffective and inefficient linkage between R&D and the commercialization of technologies. This has not been considered surprising since, until recently, innovation (i.e. the successful introduction of a new product or process into the commercial market) was not considered a priority of U.S. Federal R&D [10].

I.6.2 R&D, Innovation, and Commercialization

To better understand the reasons for the deficiencies of the old model and the characteristics and attributes which underlie the emergence of the new model, a closer investigation of R&D and innovation and their interrelationship and impact in the new commercialization driven paradigm is warranted. Such an investigation reveals the following [10]:

*The linear process starting from basic research and leading in a sequential manner to applied research, technical development, and new industrial products, processes and methods is becoming increasingly irrelevant for the current techno-economic paradigm.

*The commercialization of technologies requires much more than R&D.

*Innovation is a complex mix of many activities including the technical,financial, management, design, production, and marketing steps involved in the commercial introduction of a new (or improved) product or manufacturing process . Each of these activities affects, and at the same time is affected, by R&D. Innovation thus possesses a complex interactive,reiterative, interdependent nature which makes it difficult to comprehend within a consistent, theoretical framework.

*Basic research is not essential for commercial technological innovation, particularly with regard to the innovation of complex process and product technologies.

* The acquisition,exploitation, adaptation and diffusion of technologies have become as fundamental to the process of innovation as the performance of R&D.

*Where radical innovations of relatively simple technologies are the route to success- i.e. in sectors like pharmaceuticals or chemicals- basic research and the linear model of innovation remain important.

*The innovation of many high-valued-added complex technologies is much less dependent on basic research. Incremental improvements of a complex technology like an automobile involves little reliance on new or recently produced fundamental knowledge. Instead, the commercialization of cars depends on knowledge (much of it tacit, often embedded in organizations) created by design, development, manufacturing, etc. as well as by basic research.

*In today's world marketplace, complex product technologies are increasingly important accounting for perhaps 75% of the value of technological trade, while simple technologies constitute only about one-quarter of the total. This trend towards more complex products and processes has been on the upswing in recent decades.

* A successful R&D strategy designed to support the commercialization of complex technologies is likely to have little to gain, in a direct sense, from basic research.

*Commercially successful innovation commonly takes place through small, incremental improvements carried out on a continuing basis. As complexity expands the opportunity of incremental innovation normally increases. All those components, architectures, and subsystems are potential targets for incremental modifications.

*The incremental approach is particularly relevant where product cycles are shortening and speed to market is crucial.

*Complex technologies are the most commercially valuable processes and products in the world market today.

*The trend towards, increased complexity is visible in many processes associated with traditional simple products such as textiles and bulk chemical products. As a result of cumulative incremental process innovation in the chemical industry over the past two decades, the complexity of chemical processes has grown exponentially, with little modification taking place in the products themselves. Such sustained process innovations, have resulted in increased production cost-effectiveness, and market penetration.

*Improving complex processes (and through them their products) is as much about organizational innovation as it is about enhanced technical abilities. The organizational dimension of process technology is as significiant as the hardware. Complex process technologies always have to be created in an organizational (and therefore human) context.

*The new paradigm of production is characterized by complex "socio-technical" systems which organize human beings, facilities, hardware and software in new ways. The resultant "social resources" are what increasingly determine quality, costs, and other product performance advantages.

*Contrary to popular belief, the new paradigm involves a shift away from a hardware-centric view of technology and innovation, a view that pervaded in the 80's with some disastrous consequences, towards a more human-centric view with human beings and human skills back in center stage.

*The growing significance of the human factor in the new paradigm derives from the following:

1)The more complex products become, the more quality is dependent on upgrading of all stages of manufacturing and demands the full dedication of all employees at all levels.

2)The more sophisticated manufacturing technology becomes, the more it is vulnerable to and dependent upon human skills for control and maintenance.

3)The more customized production is, the more human intervention is necessary with regard to innovation-changeover, setting up machines, adaptation, adjustment, and control demand considerable human intervention.

4)If products demand a high service input and after sales service and maintenance, skilled people are required to deal with this.

5)The shorter the life cycle of products, the more innovativeness comes into play; takeoff phases occur more frequently and their mastery is dependent upon experienced personnel with formal and tacit knowledge to overcome new challenges connected with the starts of a new product.

I.7 Broad Implications For National S&T and Innovation Policies and Strategies

The following broad implications for S&T and innovation policies and strategies derive from the characteristics, developments and trends associated with the new techno-economic paradigm, and which have been highlighted in previous sections of this study:

*R&D resources, considered as the core competencies and activities for technical change in the 60's and 70's, is no longer a valid proposition.

*R and D capabilities and activities are presently being considered as only the tip of the iceberg, only one part of a much wider set of activities that contribute directly to technical change. R and D capabilities do not directly equate to technology/innovation capabilities.

*As Bell has noted, the total iceberg must include the wide range of engineering activities through which the results of R&D must pass before they result in the commercial, productive use of technology; it is frequently those various kinds of engineering that generate the effective requirements for new knowledge inputs from R and D. In other words without a complex of activities concerned with design engineering, project engineering, production engineering, process engineering and so on, R and D is usually effectively disconnected from, and can contribute little to technical change [11].

*Bell further points out that even without any direct inputs from R and D, those various design and engineering activities are frequently sufficient in their own right as sources of technical change in [manufacturing enterprises], especially as generators of the continuous paths of technical change that are now recognized as integral features of the process of technology diffusion.

*As a confirmation of the above assertions, there are many cases where the formal R and D activities do not represent the main input for innovation processes. A significant source of innovation for the entire industrial system is represented by design activity in the capital goods sector. Design is a part of engineering activities which are among the primary sources of industrial innovation. In the Italian context, for example, several studies have confirmed that innovations have very often derived from activities carried out in SME's devoid of formal R and D departments, and that research is often carried out by entrepreneurs, technicians and foremen [12].

Japanese industrial enterprises are also known to encourage and create a climate for the pursuit of innovative activity at all levels of the organization, including that of production workers, as part of a process of continuous technical change.

* S&T policy has very often concentrated on R and D policy and has been commonly linked only very weakly to policies related to the accumulation and development of technological and engineering capabilities identified above, which constitute cornerstones for

sustained technical change in many sectors and economic contexts.

*S&T policy has often heavily focused on influencing only the activities of specialized S&T institutions (mainly public-sector R and D institutions). It has commonly had very limited links with the technological activities of manufacturing enterprises.Indeed as Bell points out , these enterprises are all too often classified as users of the outputs of the " S and T system".

*Industrial enterprises have a major role to play in technical change and innovation, much of it based on the broad spectrum of engineering activities identified above and which rightly belongs within those enterprises. In developed economies it is within such enterprises that most technologically based innovation activity takes place. They therefore constitute major elements within the S&T systems of developed countries.

*Since the current techno-economic paragigm is people /skill/ knowledge driven, national S&T policy should emphasize a "people oriented technology policy" which involves upgrading training and skills, and support for basic science, math and engineering education.

*Government S&T policy should incorporate in an explicit manner an element related to innovation policy. It has been argued in this study that the ultimate yardstick for technologically based competitiveness is innovation which is an integrative concept encompassing science, technology, R&D, engineering, as well as other factors crucial to the process of technical change. Innovation policy represents the combination, in a coordinated manner, of science and technology policy and industrial policy [13].

*Underlying the paradigm shift occuring in the organization and objectives of publicly funded S&T is the growing realization that the key issue for government in using S&T to promote economic welfare is not the creation of new scientific and technological knowledge but the diffusion of existing knowledge to where it is most needed and can do most good [9]. This represents a demand driven paradigm shift oriented towards the application of R and D results and the rapid coupling to engineering, production and marketing as part of an overall commercialization cycle.

*Even in developed countries such as the U.S.A. where an extensive system for innovation and commercialization already exists within the bounds of enterprises themselves, there is a mounting call in both the private and public sectors for a more direct government involvement in the promotion of commercially oriented R&D [10].
This role becomes particularly significant with the intensification of international competition and the growing need to support national public and private enterprises in areas where their proper means and capabilities may be deficient. In fact, the laissez-faire U.S. attitude on civilian industry and technological innovation is only apparent. In reality informal support and indirect support have been provided [13].

Japan's innovation policy on the other hand has been explicit, planned and coordinated. Sweden's national industrial innovation policy has been characterized as centrally planned while that of the U.K. has been considered a mixed system [14].

Each of the above models of national innovation policy produces a different development climate which is further constrained by other aspects of the national politico-socio-economic system. What is significant however is that the global trend toward liberalized trade, open markets, deregulation and the rising growth and support of private sector enterprises, does not imply less government involvement in national S&T and innovation policies and initiatives.
In fact, the opposite trend is more likely, and in particular in the developed economies. Developing countries should therefore be particularly wary of misguided calls for less government involvement in S&T and innovation policies and strategies under the pretext that such government involvement is a vestige of an era gone by or the instrument of a centrally planned command economy.

II.Developing Countries, the Current Techno-Economic Paradigm, and S&T and Innovation Policy and Strategy Challenges

Part I of this study related essentially to the global context and the related evolving environment associated with business, technology and markets. Major global trends and their impact and implications were noted particularly regarding the new policy framework that is emerging concerning S&T, R&D, innovation and commercialization, the role of government, and the roles, missions and activities of national R&D institutes. Part I clearly confirmed the major shifts taking place in the conventional wisdom that had prevailed in previous decades on these issues.

Part II will focus more closely on issues which are particularly relevant for developing countries and, by implication, countries of the ESCWA region.

II.1 Developing Countries and the New Techno-Economic Paradigm

Many developing countries (as well as many communities in developed countries) are facing major economic problems due to the collapse of their traditional sources of wealth. These may include raw materials, cash crops, traditional industries, labor-intensive agriculture, arts and crafts, import barriers, government subsidies, guaranteed exports, government procurements and low-cost labor[15].
Three major interrelated factors are contributing to this decline.
These are :

1) Technology which is being used to great advantage by enterprises in developed countries but only marginally by developing country enterprises.

2) The growing global competition which is turning into a classical Darwinian struggle for survival of the fittest.

3) The new world economic order essentially characterized by open markets, liberalized trade and the removal of trade barriers, and products conforming to high quality standards.

Many communities and countries are now examining new strategies for rebuilding their economies using the leverage offered by the new techno-economic paradigm for promoting new industries or enhancing the competitiveness of traditional or mature industries. This trend places major emphasis on private initiatives and the role of the private sector in the creation of a multitude of technology intensive companies under the umbrella of governmental regional and economic development plans fueled by a broad spectrum of economic and non-economic incentives and hopefully by financial and technical assistance from the richer communities, countries and national and international development organizations[15].

This "hi-tech" approach as a solution to the broad problems of economic development particularly for developing countries has been the subject of debate in recent years with cautious as well as optimistic viewpoints being expressed.

The following arguments have been presented in support of the cautious view[8]:

*Each country has to respond (based on its own socio-economic-cultural conditions) to the challenges and opportunities of S&T.

*Loosening the grip of technological dependence in a few privileged sectors ultimately makes the whole economy much more vulnerable and threatens social harmony.

*Development policy cannot be reduced to a straightforward technical operation aimed at raising the economic efficiency of key sectors cut off from the rest of society.

*Technological pluralism is a necessity. That is not to say that the traditional methods should not benefit from improvement in productivity through the introduction of more advanced technologies. On the contrary, mastery of many elements of the new techno-economic system makes it possible to modernize traditional sectors (e.g.the application of information technology).

*Blending of new and traditional technologies, and the deliberate management of technological pluralism to make use of products and processes with different levels of productivity are the only options able to satisfy both the economic constraints and the real social demands in most of the developing countries.

*The above option is less prestigious and at the same time more difficult to implement than one in which advanced technologies are imported regardless of cost. On the other hand, it is the one which will make it possible to extend improvements in hygiene, housing, nutrition, health and employment to a greater portion of the population rather than to a limited group which benefits from a process of accelerated growth in a few sectors of the economy.

*It may appear that the "late-comers" in the race for industrialization may even enjoy a comparative advantage in that there is a pool of available technologies they can import, imitate or improve without having to take on risks and costs born by the "poineers". One should not conclude however that developing countries have a greater room for manoeuvre in exploiting new technological opportunities. Such an option does not hold for the vast majority of developing countries. On the contrary, the new technical system emerging threatens to increase rather than to diminish the gap between the industrialized and the developing countries.

*The new technical system relates to information and communication technologies, biotechnologies and new synthetic materials. The distinctive feature of these new technologies is that they are extremely capital intensive , not simply in terms of financial resources, but also in research facilities-labs, equipment-and they require highly qualified personnel.

*Leapfrogging in today's paradigm is more difficult than in the past : in the information revolution, the design development and spread of new technologies require enormous capital investment, close links between universities and industry and large numbers of scientists, engineers and technicians, as well as specialists in management and marketing.

*The technological gap is widening because economic disparities interact with features of the new technological system to create a further barrier separating mastery of production from mastery of use of the new technologies. Only a handful of countries and firms can produce the very advanced goods and services so essential for comparative advantage in a given sector if not for the future of the entire economic system.

*Mastery of the use of the new technologies already involves substantial costs in infrastructure and training of qualified manpower.

*Microelectronics and the spread of flexible computer systems may well allow a greater number of countries to take advantage of the new techno-economic paradigm. S&T opens up new opportunities, extends the range of available options, and provides means in some cases for a "leap-frogging development strategy". Yet in order to introduce and spread the new technologies, even if only to modernize traditional industries, investments are required that must be made at the expense of other priorities.

*Even if the information revolution allows some developing countries to adopt and sometimes to succeed in policies aimed at catching up in certain sectors, the revolution does not provide in any way- nor anywhere- a short-cut to overcoming the fundamental problems of development : hunger, unemployment, health and education.

The above arguments reflecting a cautious (if not pessimistic) view on the significance of the new techno-economic paradigm for developing countries, should be closely scrutinized. Overall, these arguments strongly suggest that 1)developing countries cannot expect to gain much by way of economic and social development if they should adopt a development strategy strongly based on this techno-economic paradigm, and 2) that this techno-economic paradigm is beyond their reach anyway (due to its capital intensity,etc.)

The above notions are both dangerous and misleading since accepting them essentially seals the fate of developing countries and condemns them to a perpetual state of underdevelopment alienated from the mainstream of the modern age and cut-off from the means and tools modern science and technology provide for the achievement of economic and social development.

It has in fact been repeatedly and consistently demonstrated that prominent societies throughout history were those that had successfully harnessed the science and technology legacy of the times and integrated it within their economic and social fabric.

A close investigation of the arguments associated with the cautious view in fact reveals several obvious contradictions. The assertion that modern technologies are highly capital intensive is both erroneous and misleading as a broad generalization. Establishing extensive highly automated hardware intensive manufacturing facilities is certainly capital intensive. However this is only one aspect of the current techno-economic system which may be suitable for major corporations and large enterprises. The new techno-economic paradigm in fact offers innumerable opportunities /entry levels for innovation and the achievement of added-value to small and medium scale enterprises. This is due to the "knowledge intensity","skill intensity", "design intensity", " software intensity " and "management intensity" of the current paradigm, which are more dominant than the "hardware intensity" characteristic that is often invoked.

These "soft" characteristics have been emphasized in previous sections of this study. In fact the central thesis adopted in this study is that better and more modern technology (not necessarily hardware intensive) is needed for developing countries and their enterprises for survival of both their public and private sectors. In the present era of deregulation, privatization and global competition such survival implies the ability to compete through technical change and technological innovation appropriately integrated with economic and business strategies. This presents developing countries and their enterprises with major challenges which relate more to the management, development and upgrading of individual and collective human resources and skills than to the provision of huge capital resources for the purchase of massive hardware.

Further arguments supporting the importance and significance of the new techno-economic paradigm for developing countries, reflecting the optimistic viewpoint, are presented in the following [3]:

*A mature product or process, characterized by a consolidated stable performance tendency, is normally associated with structured markets and advanced, competing industrial firms in which technology is an important competitive factor, therefore inhibiting access and transfer of information. For a developing country to establish such an industry is expensive, difficult, and complex requiring "infant industry" import barriers which create difficulties in international trade relations.

*On the other hand, new basic technologies or new paradigms involve much experimentation, many new and small firms, and more open access to and transfer of information about the new technology.

*For developing countries, technology transitions involving new paradigms represent "opportunity windows" for technology transfer, which do not always require foreign technology transfer.

*For developing countries, the exploitation and development of new technological paradigms offers the potential for faster economic development without having to overcome the economic and technological advantages possessed by advanced countries in mature industries.

In his preliminary report entitled "Towards a Science and Technology Strategy for Syria", prepared with the support of UNIDO, Mullin expressed a relatively positive position relating to the significance of new technologies for developing countries and the required policy objectives [20]. His main points were the following:

* In all of these fields [informatics (broadly defined), biotechnology, and advanced materials] developing countries face both opportunities and challenges.

* Mastering some aspects of these fields could revolutionize their economic performance. They also may carry the prospects of further major weakening of their already fragile economic position, particularly if the industrialized countries move, technologically, in directions which consume significantly smaller quantities of the resources whose exportation is crucial to most developing countries.

* These fields of technology are able both to give rise to entirely new industries and to bring about significant imrpovements throughout the existing sectors of any economy.

* The contribution of these new technologies to the enhancement of the economic performance of existing industries, particularly those using aging technologies, is likely to be of significantly greater economic importance, in the short to medium term, than the economic importance of completely new industries to which they may give rise.

* A primary policy objective of developing countries must be to facilitate the diffusion of such new technologies throughout their own economies in order to allow their existing investments in industrial development to have a chance of surviving in the increasingly open and competitive markets which are looming on the horizon.

Habibie has expressed himself as a firm proponent of sophisticated technologies and their application in developing countries [21].
He considers technology as the major motive force behind value-added processes, including raw materials processing and the transformation of raw materials into finished products. The more efficient the value-added processes, the higher the standard of living. Given the concrete problems faced by the underdeveloped part of the world, Habibie considers that there is no point in classifying technologies as elementary, intermediate, high, appropriate, and sophisticated, as is frequently the case. To say that to forecast the weather, to eradicate pests, to overcome natural disasters, to obtain clean water, or to improve agricultural productivity, Third World countries should use primitive technologies is to strengthen the vicious circle of ignorance and poverty.

II.2. Policy Issues of Specific Relevance to Developing Country S&T and Innovation Systems

Many of the issues and implications addressed in Part I are relevant for national S&T and innovation policies in general, within the context of the current global techno-economic paradigm. Some are particularly significant for developed country environments while others should be particularly emphasized for developing country environments. Important issues and considerations relating to developing country environments are further highlighted in what follows:

* Developing countries suffer from basic weaknesses in the various elements of their S&T systems and their national systems of innovation. The problem is further compounded by the weaknesses in the links between the various elements, and in particular between the R&D activities and the production system.

* R&D activities, wherever existent, have been concentrated in national (or sectorial) R&D institutes. The weaknesses have stemmed, in part, from inadequate commercialization of R&D, due to inadequate mechanisms for promotion, demonstration and dissemination of R&D results, inadequate resources for techno-economic and market feasibility studies to establish commercial viability, as well as a lack of understanding about the capabilities and potential of R&D institutions to impact on the realistic needs of the production system.

* The issues and implications however are far more profound, diverse, and complex. A critical deficiency which undermines the entire national system of innovation in developing countries in general, and in the ESCWA region in particular, is that public and private enterprises exhibit little or no innovation capability and activity. Such enterprises have until now with reasonable justification been considered users of the "outputs" of the "S&T sytem", or "adopters" of externally developed technologies. This viewpoint however must now be seriously challenged, since it serves the purpose of perpetuating a very distorted situation.

* Indeed, if this status quo, is allowed to persist, there is little hope that the developing country public and private institutions can sustain a competitive posture no matter how many doses of externally generated R&D and innovation are injected into them. S&T policy should therefore be squarely directed at nurturing innovative capability and activity within these enterprises, in addition to maintaining support to specialized S&T institutions. Such a policy framework would ensure that these enterprises become part and parcel of the national S&T system. Within such a policy framework, national S&T institutes must assume a new role in addition to their presumed traditional role as R&D and technology providers to public and private enterprises (a role whose impact, in general, on such enterprises, has been limited at best even in developed countries as previously indicated).

* A main objective of the new envisaged role is to help create and enhance innovative capability and activity within public and private enterprises, as well as to nurture stronger links between the national institutes and these enterprises and between the enterprises themselves. Such links will help sustain commercialization of R&D activity performed in national research institutes as well as technology exchange and interaction among the enterprises.

* To perform such a role effectively the core competences of national institutes should extend beyond R&D to include engineering, technology diffusion, and technical assistance, which should enable them to better support public and private enterprises in the process of innovation.

* Due to the weak science and technology system and infrastructure in developing countries, the contribution of national institutes to scientific and technological capacity development in these countries becomes vital[16]. Such development relates to the formation of human capital, training, the disposition of territorial infrastructure and the most suitable ways for organizing self-support[17].

* Since developing countries face many constraints with respect to natural resources, technical infrastructure, manpower and time, which are required for technological development, certain industrial sectors should be selected according to their development priorities. The present needs and future prospects for these sectors should then be identified, on the basis of which a suitable technology development strategy should be elaborated which may involve a mix of technology acquisition, assimilation, digestion and local development[18] . National institutes have major roles to play in the entire process largely due to the current deficiencies and the limited capabilities of public and private enterprises in developing countries in this regard.

* Developed countries have been able to sustain major deficiencies in their national S&T institutes because most innovation capacity in such countries has resided in enterprises. By concentrating their S&T efforts in national institutes, and by patterning these institutes along the lines of their (deficient) counterparts in developed countries, most developing countries have in effect undermined their

national system of innovation since the productive sectors have essentially been locked out of the system. Any process for revitalizing national institutes so that they may play a more effective role in national development must resolve this critical imbalance.

* National institutes must therefore better position themselves to provide national public and private enterprises with a broad range of technological infrastructure support as well as technical support services which would enhance the capability for innovation of such enterprises. National institutes would act both as channels and as intermediaries for technology transfer, helping public and private enterprises tap the large reservoir of technology available in the public domain or through sales, joint ventures and license agreements. It is in fact noteworthy that non-formal channels of technology transfer are no less important than formal channels[19]. To perform this role effectively national institutes must significantly expand their own capability and the associated mechanisms for the acquisition, exploitation, adaptation and diffusion of technologies, including those that are mature as well as those under development.

* The development of a sustained capability for innovation cannot however be achieved through a process of periodic technology transfer to the enterprises concerned. In fact technology transfer cannot be regarded as fully accomplished until the technology has been made indigenous and "regenerative" through complete digestion and absorption. Little can be expected from imported technology in the absence of a capability to modify and improve it for domestic application[18]. Appropriate account should therefore be taken of the interrelation between the importation of technologies and domestic R&D (and engineering) efforts, and the achievement of an optimum balance. National institutes can play an effective role in this regard as well, by helping enterprises elaborate appropriate technology strategies, by performing domestic R&D using their proper resources, and by helping enterprises build their own internal resources and core competences within the framework of the technology strategies elaborated. Sharif[6] has traced the technological potential of an enterprise to four " basic components of technology " which have been termed technoware, humanware, infoware, and orgaware. National institutes should thus be involved in programs that seek to improve

the degree of sophistication of these four components thereby enhancing the innovativeness capabilities and competitive posture of national enterprises.

* Achieving effective interaction, complementarity and synergy between elements of the national S&T and innovation systems and the creation of an environment conducive to technological innovation, technical change and the implementation of such change in a sustained manner, require a major national effort which can only find expression in explicit policies, strategies and plans, related to the development of national S&T and innovation systems, with government playing a major role in formulating and directing them.

* The government role is paramount, particularly in developing countries. The weak policy foundations and concomitant weak development strategies greatly retard the promotion of S&T. It thus becomes essential to establish effective science policy mechanisms and to establish an adequate infrastructure conducive to S&T development for a variety of reasons, including:

- Public enterprises constitute the major economic sectors for many developing countries and are most directly affected by government policies, strategies and plans.

- Government policies, programs and practices at the macroeconmic and social context affect and constrain directly and indirectly, and at many levels, the technical performance and the capacity for innovation of public as well as private enterprises.

- Through its national industrial policy, the government directly influences the industrial structure (and its coherence or lack thereof), as well as the development patterns of each industry and the associated industrial leverage strategies (e.g. controlled competition,closed market ,...).

- Due to the weak S&T and innovation capacities of public and private sector enterprises in developing countries, governments must play a major and direct role in providing technological infrastructure, in establishing and promoting national research institutes, in supporting and financing mission-oriented R&D programs, and in developing and upgrading the education and skills capabilities of the technical and managerial workforce.

- Without active support at the highest levels of government, no S&T system can realize its full potential[20].

II.3 Basic Issues Underlying the Difficulties and Complexities of Elaborating S&T and Innovation Policies and Strategies in Developing Countries

In Developing countries with short experiences in areas of modern S&T, the rational establishment of S&T and innovation policies and strategies is the major challenge [16]. This is due to the difficulties and complexities involved, which include the following:

* In too many instances, national attempts to foster innovation as a major component of a hi-tech economic development thrust become hollow rhetoric because they fail to fit within the national economic framework[14].

* The relationship between industrial and technological policy and national economic policy is ambiguous with conceptual difficulties on both sides. A common ground for economic, technological and industrial policies is that of technological innovation, which is a critical issue for scientific and technological policy and national development[3] .

* S&T policy is generally seen as inappropriate to the solution of immediate short-term macroeconomic problems and as a result receives low priority by government for resource allocation and top level policy consideration[3].

* Technological innovation is often poorly understood by politicians and by national economic and policy planners. They thus fail to consider that planning and management of innovation is the key to the improvement of national development efforts[3].

* Technology must be analyzed from the perspective of the innovation process involving economic production systems, S&T systems, and the nonlinear interaction of the two[3].

* For innovation process planning, government is but one of the actors. Sectors, enterprises and institutions and action units must also be involved[3]. The acceleration of technological development in a developing country requires both a top-down approach which is government driven and a bottom-up approach which emphasizes the self-efforts of enterprises [19].

* The development of an S&T strategy can only be executed within the social,legal, economic and institutional framework of the country [20].

* An S&T system with social and economic goals must have crucial linkages with industrial, health,agricultural, educational and other sectors of the national society and economy [20].

*The national S&T system consists of many components. A central policy and strategy issue relates to making these components work together in an integrated and effective manner[20].

* Policies and strategies for S&T and innovation must take due account of the stages of the technology development cycle and need to differentiate the national policy responses at various levels of development for any segment of the industry. There is thus a need for a flexible and responsive national policy framework and evolving enterprise technology strategies which consider the sectoral characteristics and their implications for technological development processes [6,14]. This requires a higher degree of sophistication in understanding technological development requirements, acquisition strategies, and sectoral differences [19].

* Science and technology policy and strategy should also include "soft" aspects such as social and behavioural issues, and cultural and political factors.

* Two domains of S&T policy should be considered [16]:
1)The long term development of national S&T potential and 2) The

promotion of the most effective utilization of S&T for national development objectives and social needs.

* There is thus a paramount need to integrate S&T and innovation policies and strategies with national development policies and strategies.

*In science and technology policy formulation issues, account must be taken of the interrelationship between the importation of technology and domestic R&D efforts, the optimum selection of appropriate technologies for importation, the assimilation of imported technologies, and the need to reduce technological dependence on foreign countries [16].

* National innovation policies should be strongly linked to the specific national needs of technology, the economic situation, geographic and cultural characteristics, etc. They also relate to the following common points [22]:

. The development of an innovation structure.
. The development of R&D and innovation programs
. The support of companies, particularly SME's.

* Decision-makers in developing countries even more than in industrialized countries need to match scientific and technical efforts to the specific circumstances in each country in order to shape its overall development. Thus the scientific and technological community ought to have a good influence on decision-makers to ensure that choices and priorities in research and innovation are appropriate for each country's needs [8].

* Innovation policy should be closely linked with industrial policy to develop a "new form of competition" which promotes efficiency and quality of production, innovative enterprise, a coherent structure and strategy for economic sectors, and consistent national macroeconomic and social policy [3].

III. The Evolution of SSRC, and the Process of R&D Revitalization

In this part of the study, the major national Syrian R&D organizations will be investigated. Emphasis will be placed on current thrusts and future orientations in response to the new requirements imposed by local, regional and international developments, and the future role envisaged for national R&D institutes in promoting technology based national development .

Many of the issues addressed in previous parts of the study are thus relevant and will be duly taken into account, particularly as reference points for evaluating significant aspects of the evolution and the current and future thrusts of SSRC.

The evolution of SSRC and the process of institution building that characterized its phases of development were traced in a previous study [23]. The rationale for the evolution of SSRC and its role was specifically investigated, with due account taken of considerations influencing the process and the objectives sought.

In the following, the major points emphasized in that study will be highlighted and further investigated where necessary.

III.1 SSRC : the Formative Years:

SSRC was established in the early 70's with the stated objective of promoting national development through the creation of a strong applied science and technology base. SSRC was conceived as a core institution set to play a pioneering role in exploiting the potential of modern technologies in national development. In contrast to many national R&D institutes worldwide, SSRC reflected from the outset an orientation towards technology and application rather than towards science and basic research.

It is to be noted that SSRC was launched against the background of a weak S&T system in Syria whether in the public or in the private sector. There had been no significant tradition of scientific activity or technical innovation in products and processes. Furthermore, SSRC was not established as part of a clearly expressed and explicit national S&T policy or strategy.

The process of institution building that ensued had as its primary goal the growth of a significant endogenous capacity for technical development through accumulation of a broad spectrum of knowledge and experience. This derived from the consideration that the build-up of a national R&D capability is a prerequisite for national innovation, whether such innovation is based on indigenous technology development or on externally acquired technology .

The main institution - building tasks for SSRC during this period included the following:

- Selection of main orientations/disciplines
- Manpower development
- The building of technological infrastructure
- Conduct of in-house R&D
- Technology transfer and assimilation

III.1.1 Selection of Main Orientations/Disciplines

The following three major technical disciplines were originally incorporated into SSRC: Electronics, mechanical engineering, chemical engineering.

The rationale for such a selection is evident since these three disciplines jointly underlie most industrial activities, products and processes . A nontechnical discipline was also originally incorporated into SSRC, namely economics and management. This reflected the recognition that technology (in its strict technical sense) cannot on its own generate competitive products and processes; it has to be coupled with sound management, organization and economics to achieve cost-effective development and production as well as commercialization and marketing.

Soon thereafter, an informatics department was also set up reflecting an early appreciation of the anticipated growing role and impact of informatics in modern development and society.

In selecting its main orientations/disciplines with a strong emphasis on electronics and informatics, SSRC was thus positioning itself in line with the emerging techno-economic paradigm. Although not part of an explicitly stated national S&T policy, a strategic choice had in effect been made which emphasized high technology as a cornerstone of activity at the Syrian national R&D institute, i.e. SSRC, and therefore, in principle, as an important element of national development strategy in the future.

III.1.2. Manpower Development:

The development of manpower resources through education, training, and the build-up of expertise by performing R&D and engineering work as well as management activities, is the principal pillar of an effective national R&D organization.

The "pioneers" at SSRC were a core group of researchers comprised of academics in engineering, physics or chemistry, as well as specialists with some industrial experience. Upon them fell the major tasks of planning and organizing for the start-up phase including laboratory set-up and equiping, the selection and recruiting of essential technical staff (engineers, technicians), and the elaboration of initial programs of activity. Department heads were provided with a high degree of latitude in selecting the main directions and programs of activity in their respective departments and, concomitantly, in the selection of the relevant laboratory equipment.

This reflected, in part, the science push approach which dominated the perceptions of scientists and researchers in that period, both locally and worldwide. Furthermore,and in the absence of well defined plans and programs, the accumulation of knowledge and experience within the newly formed departments became in itself a major (and justifiable) goal in the formative years of SSRC.

The subsequent expansion of SSRC activities necessitated the institution of a permanent program for supporting advanced education and training abroad as an important strategy for manpower resource development.

A major initiative was undertaken in the late 70's which led to the establishment of the Higher Institute for Applied Sciences and Technology (HIAST), which has since evolved into a major national instrument for technology based manpower development in Syria, as well as a technology based institute in its own right which seeks to make a contribution to national development. The expanding role of HIAST is briefly addressed subsequently. A detailed overview and investigation of HIAST is presented in a seperate paper.

SSRC also instituted in its formative years various programs and mechanisms for the continuing education of its staff. As for training programs abroad, they proved to be successful when they were customized, purpose oriented. Standardized, group or individiual, training courses abroad have had more limited success however.

III.1.3 The Establishment of Technological Infrastructure

The second major task after manpower development confronting a nascent R&D institute is the establishment of technological infrastructure. This task posed a broad range of challenges, including:

1) The provision of adequate funding.
2) The selection and procurement of equipment, and the training of staff in their use where required.
3) The set-up of appropriately serviced facilities and laboratories.
4) Organization and management of the facilities and laboratories.

The establishment of technological infrastructure proved to be a very demanding task requiring major efforts by management and staff.

III.1.4 Conduct of R&D

During the formative years the conduct of R&D per se became a central objective of SSRC. The underlying rationale was that it was essentially through such a process that the development of a critical mass of core competences and a firm base of experience could be achieved. This in turn was considered a fundamental prequisite for any potentially significant future role for SSRC in promoting technology-based national development. An important phase of the process of institution building had to be completed before SSRC could project itself as a viable entity within what was essentially a rudimentary and weak S&T system environment.

The potential future impact of SSRC was thus very much predicated on how successful it would be in incubating and growing within its own shell during the formative years. In developing countries in particular, immature early exposure to potential beneficiaries by a nascent institution such as SSRC could be very detrimental to its credibility. In focusing on the building of capability and the conduct of R&D in the formative years, SSRC was in effect involved in building the foundations for its future credibility.

Another rationale for conducting R&D derives from the important consideration that R&D not only generates new information and innovations, but also enhances an institution's ability to identify, assimilate and exploit existing information and knowledge from the environment. This has been termed an institution's 'learning ' or 'absorptive' capacity [24].

Through in-house R&D conducted at institutions such as SSRC, the required adaptive skills can be developed which would result in improvements to externally acquired technology. In-house R&D can also lead to an increase in the bargaining power of the related institutions, in the ability to identify alternate suppliers, raw materials, etc. and in monitoring developments around the world thus facilitating the evaluation and selection of technologies.

III.1.5 Technology Transfer, Acquisition, and Assimilation

Essentially all R&D and industrial activity involves technology transfer and/or acquisition in some form. SSRC was involved in its formative years in various types of simple technology transfer/acquisition activities.

An important aspect of the institution building process at SSRC related to the assimilation of the various transferred and / or acquired technologies. This has been identified as a crucial activity for newly industrialized and developing countries both as a learning process and for the purpose of subsequent improvement through creative adaptation [18] . The integration of in-house R&D with external technology was earlier identified as an important process underlying effective technological innovation within institutions and enterprises.

SSRC had recognized early on the rising significance of external linkages and technology transfer and acquisition strategies in the performance of R&D activities. Subsequent phases of its evolution witnessed further expansion and new modes of technology transfer, acquisition and assimilation .

III.2 The Evolving Structure of SSRC and its Activities

The process of institution building at SSRC during the formative years was followed by a new phase of structural consolidation which reflected a new focus on the output of its R&D activities and their application in products and processes relevant for industrial and economic development.

The various departments were restructured into institutes where downstream activities were given due emphasis. This required a shift from an " R&D orientation to a D&E " orientation ("E" for engineering).

Though not clearly evident at the time, in retrospect this was a fundamental and potentially very significant shift. It confronted SSRC with a host of new and complex technical, organizational and managerial challenges. To paraphrase Bell, tackling the iceberg proper is a far more daunting task than tackling its tip.

This restructuring with a strong engineering orientation echoed similar trends underway in national laboratories worldwide, in their quest for more relevance and a greater practical impact. Market oriented R&D, the commercialization of R&D and related concepts, became expressions of the new trend which was elaborated in Part II of this study.

III.2.1 New Emphasis on engineering Design and project management

At SSRC, engineering design activities received new emphasis in step with growing world-wide trends which focused increasingly on engineering design as a key strategy for innovation and for achieving product competitiveness in many industries.

The new emphasis at SSRC on R&D outputs and products also necessitated the application of effective project management and enigineering approaches which involved experimenting with a variety of models to determine the relative merits in particular contexts and organizational structures. As Bell has pointed out[11], project engineering is a key aspect of the many engineering activities involved in the (competitive) development of products and processes, as well as in production activities.

III.2 Evolution of Production Activities

Production activities are not normally associated with classical forms of R&D institutions. SSRC however took the bold step of extending its scope of activities to include prototype, limited and small scale production. This industrial experience proved to be particularly valuable. It helped break down the traditional barriers that often exist between research, development, design and production by providing an integrated experience . This point is particularly significant for developing country R&D organizations which often operate almost in isolation from industrial activity (i.e. engineering design and production). With such an exposure and experience, R&D people are far better prepared to play a role in promoting industrial activity and development and in interacting with industrial firms and offering solutions to their problems. By completing the industrial cycle (development, design, and production) SSRC was also positioning itself for a potential future role as a center for industrial technology transfer to domestic industries.

III.3 The Evolving Role of HIAST

The Institute of Applied Sciences and Technology (HIAST), mentioned previously, was established at the time when classical academic education in science and engineering fields was being increasingly scrutinized in Western countries. The relevance of such education to industries facing growing threats from the Far East was being called into question. Intense efforts were expended to modify curricula such as to reflect a new purpose for universities, namely applying knowledge to the real world [5]. Education as well as research needed to shift from the traditional single discipline focus to an

increasingly multidisciplinary focus. This would be more compatible with the new reality which entails a more direct connection between fundamental science , engineering and their commercial application.
Traditional science and engineering education and research in developing countries has been compounded with further problems including :

* Lower quality education
* Lack of adequate facilities for laboratory work
* A high student-to-teacher ratio
* Little research activity conducted by faculty

HIAST was established against this dual background, namely the new orientations in science and engineering education and research in the West, and the unsatisfactory and inadequate education and research system characteristic of developing country universitites as outlined above. HIAST may be defined as an institution for education and research at advanced university level in select areas of science and technology that have not received the required emphasis in traditional Syrian universities. The main specializations at HIAST include :
Informatics; Systems and Control; Applied Physics; Economics and Management.

HIAST has sought to integrate high quality education and research with both a firm theoretical foundation and a strong applied technological orientation. It has also emphasized a polytechnic multidisciplinary approach which teaches the integrative aspects of engineering so necessary in engineering practice.

A detailed overview and investigation curriculum of HIAST, its status, objectives, structure, orientations, R&D project services, current and future thrusts, and related revitalization programs

III.4 Revitalization of R&D: Future Thrusts and Challenges

It is evident from the preceeding that SSRC was continuously involved in a process of "revitalization" since its inception. That process was in part, until recent years, largely internally focused. That is, its objectives were to expand and strengthen SSRC's core competences with a marked shift towards development and engineering. Such capabilities, as previously suggested, are particularily relevant to, and fully compatible with, the requirements and characteristics of the current techno-economic paradigm. It is appropriate to emphasize that the process of evolution of SSRC and its main orientations and activities are a clear expression of its commitment to the application of modern technologies as a major instrument for the promotion of national development.

SSRC's core capabilities provide it with a significant potential to play a growing role in supporting technology based national development. These have allowed it to generate an output of products, processes, and various technical support services for application in the national economy. The process of commercialization of R&D results has been only partially effective however. A broad range of activities in the commercialization process still need to be improved upon or mastered. SSRC should also more effectively promote the process of technology commercialization by setting up, or being associated with, formal institutional mechanisms for effecting (domestic) technology transfer. These become necessary due to the complexity of diffusing technology to large numbers of diverse economic agents[25].

In addition to promoting the coupling process between producers and users of technology, SSRC has an important role to play in stimulating the demand for technology in the domestic industrial and service marketplace, and in particular, the demand for locally generated technology and related products, processes and services.

A more ambitious objective is the promotion of development and innovation activities in public and private enterprises. As pointed out previously, this is a crucial aspect in the promotion of technology based national development. There is a major deficiency in Syrian enterprises in this regard. Before embarking on such an "innovation promotion program", SSRC needs to carefully analyze its many ramifications, including, above all, the strain such a program will place on its resources, considering the many sectors/enterprises involved. The process could begin with pilot programs such as some forms of incubators. HIAST is already today involved in incubator projects with Syrian industry which are described in the separate paper that is specifically focused on HIAST.

SSRC's more active involvement in the above activities (commercialization of R&D, technology transfer, creating awareness and stimulating demand for technological development), in addition to its involvement in other promotionary and support activities directed towards domestic industry and services, will considerably enhance its role in national industrial and economic development. This broad spectrum of activities, however, cannot be envisioned without the integration of SSRC and its development plans in a more comprehensive way within the national development plan. The first important step in this direction is the setting up of an effective mechanism for S&T and innovation policy and strategy formulation in Syria, to be followed with a process of elaboration of the relevant policies and strategies. The difficulties and complexities associated with all these tasks were expounded in previous sections. They represent real and very challenging issues which require concerted efforts at many levels before they are overcome. SSRC cannot on its own get the process under way, although it can, and should, play a more catalytic role. Top-level government decisionmaking is clearly required, and should initially be directed at getting effective communications set-up between the various groups that should rightly be involved in the process (government agencies, national institutes, public and private enterprises, business people, consultants,...) In principle, the moment is ripe for such a step. The Syrian economy on the one hand, is presently undergoing a process of restructuring and revitalization. The private sector, the mixed sector, and the public sector are involved in this process. There is also, on the other hand, a growing recognition in Syria of the critical role played by modern science and technology in promoting economic and social development. Many pronouncements have been made at the highest government levels in recent years to this effect. Renewed emphasis has been placed on the importance of performing R&D, and government funds have been allocated for financing such activities at national and university laboratories. However, as previously implied, no integrated policies, strategies and plans have been formulated. These are major and fundamental tasks which are yet to be accomplished.

Apart from new thrusts and strategies relating to its activities, orientations and new modes of interactions with other elements of the national S&T system, as well as with national public and private enterprises, the SSRC should strive harder to improve its effectiveness through "revitalization" of its operations. Due to the diversity of its activities, and the requirements imposed by the current techno-economic paradigm, there is a strong need for intense cross-functional interactions and transcending of hierarchical and bureaucratic relationships and structures. The current paradigm, it will be recalled, emphasizes the interaction between technology, organization and culture. Many of associated issues present more of a social and cultural challenge than a technical one. Thus, infrastructure support services must include mechanisms that contribute to organizational and cultural change [25]. Success of development activities, while based on creative ideas, ultimately depends on the organizational control and management structure [18]. Social and cultural issues can promote or hamper organizational functioning.

Another important aspect of the process of revitalization of SSRC operations is the promotion of a business culture which would reflect "cost center" concepts and related accounting procedures. In common with many R&D institutes worldwide whose funding is largely governmental, such procedures are either lacking or grossly deficient. In today's highly competitive environment, national institutes should strive to apply, to the extent possible, corporate practices. This will result in a reduction of waste and inefficient efforts, and will help in streamlining departmental operations as well as those of the organization as a whole.

On another related level, SSRC should strive progressively to depend more on revenues generated from its products and services in covering its overhead and running costs, than on governmental funding.

Conclusion

This paper has considered the process of R&D revitalization of SSRC within the context of global trends and developing country perspectives. This has in effect provided measures and reference points against which individual aspects of the revitalization process may be benchmarked.

It is apparent that SSRC has taken certain significant revitalization steps in the course of its evolution that have enabled it to become more tightly coupled within the innovation chain that is characteristic of the current techno-economic paradigm and related global trends. It is equally apparent that many significant steps and initiatives need to be effectively planned and implemented, including those specificaly considered for future thrusts. Many opportunities and challenges, difficulties and complexities, still remain. They can be effectively managed and coped with only within the context of an overall S&T and innovation policy framework. Otherwise the impact will remain piecemeal and of limited long range effectiveness. It is the elaboration of such a policy framework and its associated ramifications that constitute the challenge of first priority for the future evolution of SSRC and, concomitantly, for its future impact on national development.

HIAST, initially an outgrowth of SSRC, is increasingly assuming an autonomous role. It represents a potentially very promising institutional response for meeting the future requirements of technology based national development. The growing role and potential impact of HIAST is treated in the separate paper prapared for this Expert Group Meeting, and which specifically focuses on HIAST.

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A Syrian Case Study
HIAST in its Economic Environment

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I. HIAST Status and Objectives

HIAST (The Higher Institute for Applied Sciences and Technology) was created by a Presidential Decree in 1983, following an initiative by the Scientific Studies and Research Center. According to this P.D. It "**has an independent administration**". "**The Minister of Higher Education issues the diplomas of HIAST**". "**The Director of HIAST is a member of the Council of Higher Education**", whenever issues concerning HIAST educational programs and equivalences are dealt with.

The objectives of HIAST according to the P.D. and according to its Juridical Status are the following : "**Formation of engineers capable of performing R & D**". "**The education should be of high standard in all fields of applied science and technology in order to participate in the R & D efforts in the development process in Syria and in the Arab world**". HIAST... "**Should also aim at promoting innovation creativity, and self confidence in tackling scientific problems**" . HIAST "**has to support the management capabilities of the scientific community**". **To achieve that, HIAST should use "the most efficient educational methods and means which have to be adapted to local needs and in accordance with the actual status of advancement of S & T". "The teachers and students of HIAST should tackle, in its R & D laboratories, problems posed in Syria and the Arab World**".

II. HIAST Organization Structure

As the following diagram illustrates, HIAST has a classical structure of an educational and research Institute. Certain restructuring projects have been proposed. They aim at helping HIAST achieve better involvement in its economical environment. These proposals will be presented later in this study.

III. Activities of HIAST

The activities of HIAST can be classified into the following four main categories:

A. Education and Training

1- Undergraduate education leading to Engineering Degrees in four fields: computer science , systems engineering , applied physics, and management.

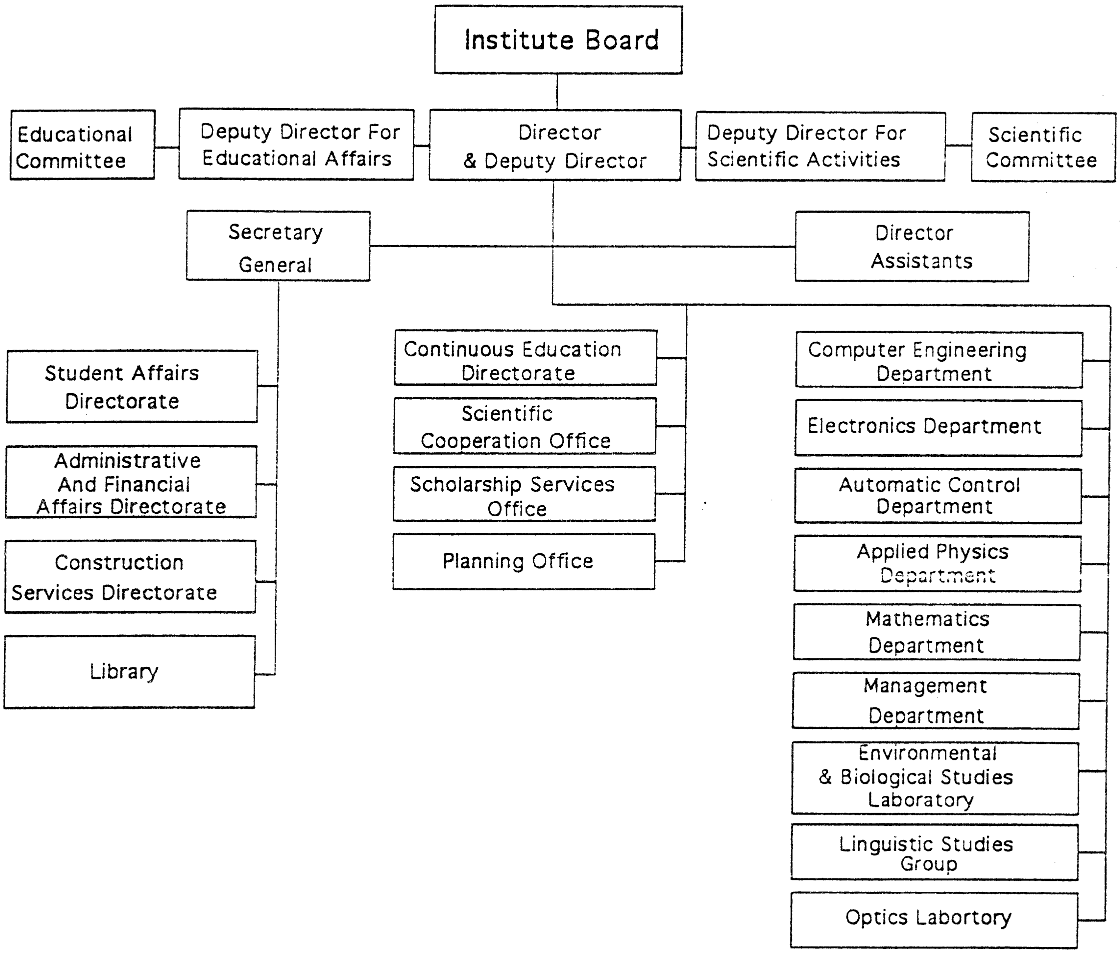
2- Higher education leading to a DES in computer science and in control. A doctoral program is also being realized. It is basically a mixed program where research is realized partly at a European university and partly at HIAST. Research themes are chosen, whenever possible, to be related to actual Syrian problems.

3- Continuous education leading to DESS degrees in computer science, mechanical engineering, communications, and management is available. Training and short courses are offered in all fields related to the activities of HIAST. Figure(2) shows the structure of courses offered by HIAST.

B. R & D at HIAST

HIAST has been constantly enhancing its R & D activities to satisfy its educational purposes on one hand and to participate in the Syrian development process on the other hand. Two main types of research are practiced at HIAST. The first one is an applied research realized through the mixed doctoral program. Examples of treated topics are :

- Arabic speech recognition
- Langage de programmation temps reel pour les outils de production.
- Diagnostic vibro-acoustique des défauts de fabrication des machines électriques.
- A vision Architecture for CIM.
- Conception et Realisation d'un Regulateur Auto-adaptatif Industrialisable.
- A semantic knowledge-based computational dictionary for supporting natural language applications.


Institute Board
Educational Committee
Deputy Director For Educational Affairs
Director & Deputy Director
Deputy Director For Scientific Activities
Scientific Committee
Secretary General
Director Assistants
Student Affairs Directorate
Administrative And Financial Affairs Directorate
Construction Services Directorate
Library
Continuous Education Directorate
Scientific Cooperation Office
Scholarship Services Office
Planning Office
Computer Engineering Department
Electronics Department
Automatic Control Department
Applied Physics Department
Mathematics Department
Management Department
Environmental & Biological Studies Laboratory
Linguistic Studies Group
Optics Labortory

The second type of activities is more development than research. It consists of an important number of projects under contract. These contracts are signed with local, regional or international establishments and are intended to solve Syrian problems. Table 1 Shows the number of such contracts signed in the last five years.

	Field of work	N° of contracts
1	Computer Systems and Networks	16
2	Management	10
3	Automation and Industrial Control	4
4	Electronics	3
5	Applied Physics	3
6	Environment	5

Examples of projects within this axis, initiated at HIAST to cope with the Syrian needs both public and private, are the following :

1- Information Systems and Data Networks

This is a main axis responding to the ever-increasing needs for information systems in the Syrian economy. It covers a wide range of projects varying from the office automation to the computerization of different ministries and government directorates. Over 16 contracts in this field are signed with HIAST Examples of such projects are :

- Multimedia archeology Information System.
- Multifont recognition system of Arabic characters.
-Study and realization of an X.25 national computer network (SYRIAPAC).
- CAD for the traditional Syrian Brocart manufacturing.
- Management system for Syrian water resources.
- Computerization of more than seven Syrian ministries, companies and banks.

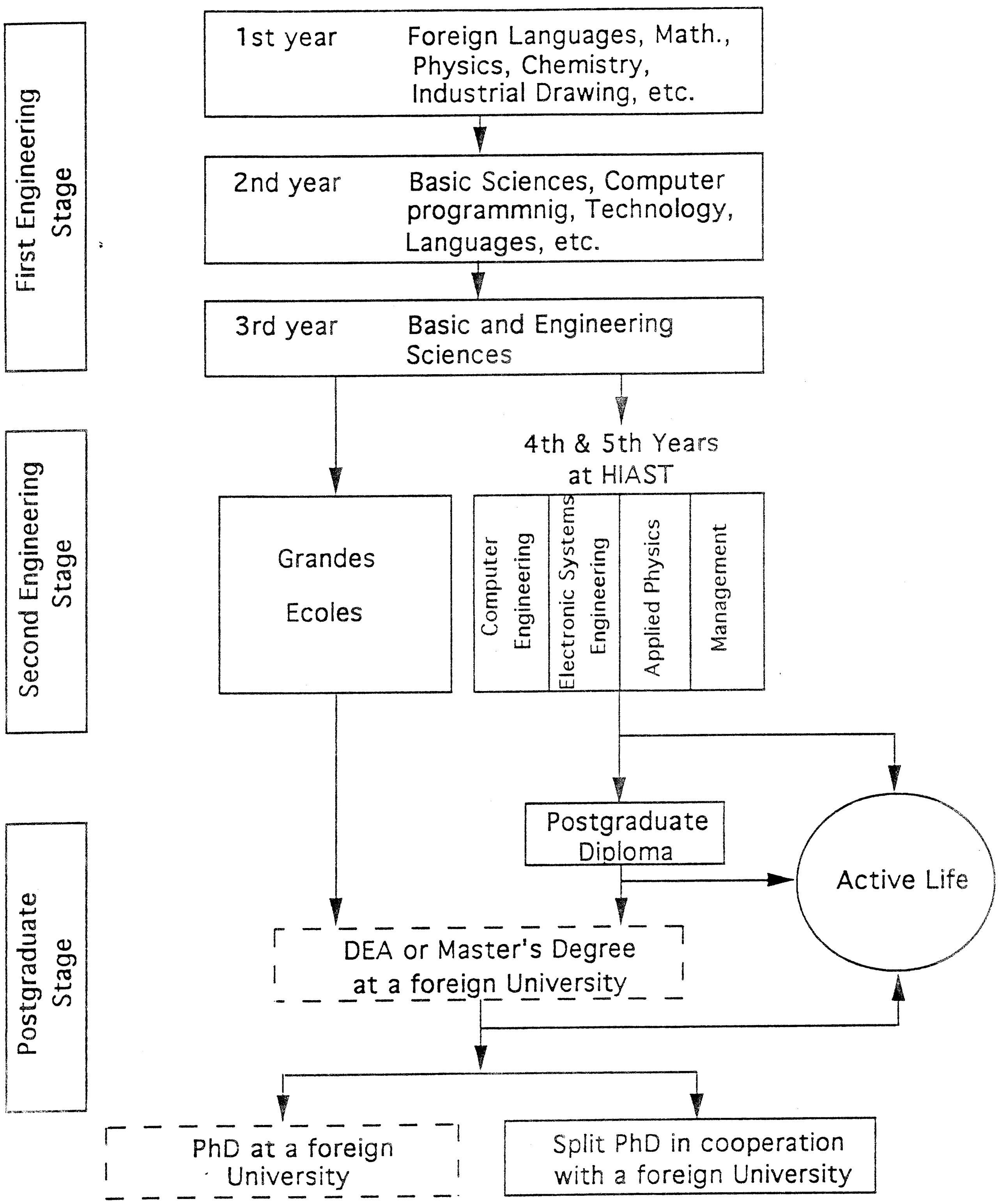
2- Automation and Control

This research topic is recent and is meant to meet the automation needs of the industrial sector in the country. Several projects have been completed in this field among them:

- Numerical control of machine tools.
- Automation of a subsystem in a sugar factory.

Structure of Courses at HIAST

(Continuous Education programmes excluded)



- Automated water treatment station.
- Autonomous submersible for searching the coast for antiquities.
- Weather meteorological sensors.

3- Management

The management department is still a small one. Its major activities were mainly directed towards management system analysis, feasibility studies, financial and cost analysis and strategies studies. Some of the projects realized are:

- Feasibility study of a touristic project in the region of Tartous (Amrite Touristic).
- National Information Center for the office of the Prime Minister.
- Study of production problems of the General Company for Cable Manufacturing.
- Design of a database on air pollution in Syria.
- Study on the computerization of the Center for Agricultural Information and Documentation.

4- Environment

Projects aim at improving the environmental and health conditions in the country through scientific activities in four domains: air pollution, water pollution, waste water treatment, and marine environment. Examples of realized projects are:

- Evaluation of the effects of phosphate loading on air quality at Tartous.
- Measurements of air quality and air pollution in major Syrian cities (Damascus, Aleppo, Homs, Banias.....).
- A sewage treatment plant for a small community.
- Controlling contaminants affecting the use and reuse of water (AVICENNES Program).

5- Electronics

Three main domains are dealt with in the electronics department namely: real-time systems, signal processing, and telecommunications. The following projects are examples of the realized projects by this department:

- Design and implementation of an automatic traffic controller.
- Design and implementation of a computer architecture teaching lab.
- A taximeter.

6- Applied Physics

The areas of interest of this department are focused on solar energy, optics, and material sciences and engineering. Example of realized projects are:

- A solar power plant for supplying electricity to two Syrian villages south of Damascus.
- Solar atlas of Syria.
- Educational optical kits.
- Optical school microscope.
- Solar water-heating systems.
- Glass-works.
- A stereoscope.

C. Services Offered by HIAST

The following technical common services are offered at HIAST :

- S & T library in the fields practiced at HIAST is available. Cooperation with other libraries in Syria has been established through which exchange of lists of books, periodicals and documents is done systematically.
- A computer center covers the computational needs of several public sector institutions in Syria.
- A chemical laboratory performs several types of analysis for public and private sectors.
- Maintenance of electronic measuring instruments is also offered.
- Moreover , HIAST tries to participate in propagating the scientific knowledge via two main bodies:

* The Publication Activity Group (PAG) responsible for publishing a variety of translated , edited and authored books.

* The Arab School of Science and Technology (ASST), with headquarters at HIAST, organizes pan-Arab and international meetings covering science and engineering topics. In its seminars and workshops lectures are presented by well known international and regional experts, and their proceedings are published and distributed internationally. Some of the latest meetings covered topics related to the growing involvement of HIAST in its economic environment:

- Product Development and Production Engineering (1988).
- Creation of Indigenous Entrepreneurship and Opportunities for Small-and Medium-Scale Industrial Investment (1993).
- Quality Assurance in small and Medium-Sized Industries (1994).
- Trade Information Networks (1994).

D. Regional and International Cooperation

Since its establishment, HIAST has been paying special attention to scientific cooperation; this is due to the awareness of its necessity for the development process. The main objectives of scientific cooperation can be summarized as follows: Cooperation in Research and Development activities, training and keeping staff members abreast of up-to-date technologies, collaboration in projects of common interest, and expertise exchange. French Universities and Superior Schools have played a significant role in the establishment of HIAST; they support the educational staff and admit the students and engineers of HIAST into their undergraduate and graduate programs, not to mention their participation in forming the curricula.

HIAST cooperates with :

1- The European Union in developing its laboratories.

2- French Universities and Superior Schools such as: GEFIE, ENSAM, ENST, ENSPM, ESE, ENSIMAG, ENSERG, ENSPG, ENS-CACHAN, ECP and ESSEC.

3- National and International Organizations such as:

- Japan International Cooperation Agency JICA, mainly in the domain of environment, the National Standards and Calibration Laboratory, and solar energy.
- UN Organizations such as: WHO, UNDP, UNESCO, UNEP, UNIDO and ESCWA.
- Development and Advanced Technologies Center in Algeria.
- The Canadian International Development & Research Centre (IDRC) in the construction of the National Data Communications Network.

4- British Universities where some of the graduates and staff members pursue their graduate studies.

5- A number of German and Canadian Universities.

6- Russian Academy of Sciences.

IV- New Proposals to Activate the role of HIAST

To be able to play a constructive role in shaping up the changes happening in its environment, HIAST is proposing to modify, redirect, and revitalize its activities. The change of the role, as it is perceived, has to be accompanied by legislative and managerial changes. First, An amendment to the Presidential Decree which created HIAST is in progress. This amendment concerns three main points related to the role of HIAST. They are:

1- More flexibility for HIAST in contracting, and consulting.
2- Improving means for self-financing.
3- Enlarging the scope of its educational services:
   a) Allowing HIAST to grant Master's and PHD degrees.
   b) Reinforcing continuous education.
   c) Accepting scholarships from public and private sectors.

Restructuring Projects

Several restructuring projects are proposed. They aim at widening the role of HIAST in its economic environment and its response to the immediate needs of this environment. Example of these projects are:

a) Creation of a Telecommunication Department

During the last few years Syria has been witnessing a continuously fast growing and expanding economy. Today the economic prospects in Syria are encouraging. This growth is manifested in the flow of foreign and national investments into the country.

This new era of economic growth and openness provided a useful impetus for the telecommunication sector which witnessed an obvious growth as well. Demand for switching and transmission equipment has grown appreciably over the past couple of years aiming at modernizing and solidifying the telecommunication infrastructure in the country. A number of projects have been completed. Others are to be carried out in the near future, among which:

* The expansion of the telephone network to 1.2 million lines by 1996.
* A GSM network in Damascus with an initial capacity of 30.000 subscribers.
* A national paging system.
* Various trunked radio systems.
* ISDN services.
* A national packet switching network (Syriapac).

Even after the completion of the mentioned projects the telecommunication services in the country would still be below what is currently available in economically flourishing countries. The failure to close this gap may cause a serious setback to the newly revived economy of Syria and consequently may jeopardize the development process. The availability of modern telecommunication services in the country is a prerequisite for the commercial and industrial exchanges with Europe and the western world. Importing of modern telecommunication equipment is the principal factor in upgrading the telecommunication services, however, it is not the only factor. Other vital factors, that in conjunction with modern equipment secure a long lasting satisfactory services, are:

- Continuous guided planning to improve the infrastructure in order to improve existing services.
- A better utilization of the available resources (networks and personnel).
- Basic and continuous education and training of the human resources.
- Providing telephony and other services to rural and remote facilities.
- Obviously the backbone of what is mostly needed in the telecommunication sector is a solution to the human resources aspect of the problem.

In order for the explosive expansion of the telecommunication services to fulfill its intended goals there must be a qualitative and quantitative expansion in the human resources that study, install, manage, maintain, and further develop the existing facilities, and plan for the forthcoming ones. This is a vital issue that should not be overlooked.

HIAST has addressed itself to the European Union for assistance and welcomes the assistance of European experts in defining such a policy and in assessing the needs. In its preliminary proposal HIAST presents its own vision of a project to establish a major telecommunication educational facility including an engineering degree, a continuing education center and a graduate program.

There are many factors that make HIAST the favorite candidate for hosting the telecommunication, program among them:

1- Establishing this program at HIAST is both cost effective and time saving. This is due to the presence of the necessary educational infrastructure available at HIAST (professors, laboratories, buildings and good students).

2- The existence of other departments at HIAST namely: computer science, systems, physics, and management. These will be beneficial to the telecommunication department. At the same time these departments will benefit too.

3- HIAST has the experience and charter of producing engineers and technicians for other institutions. Thus far, the STE and Syrianet expressed their readiness to sponsor students in telecommunications as soon as the program is established at HIAST.

4- HIAST will produce graduates in two years.

5- HIAST has many regional and international cooperation agreements, an advantage that permits HIAST to invite experts to teach and provide consultations in subjects for which the available expertise is still limited.

Project GOALS:

* Establishing a new department at HIAST in the field of telecommunications. This department shall be capable of granting undergraduate and graduate degrees.

* Establishing a telecommunication continuing education and training unit and a pilot maintenance shop as support units for the department.

* Establishing and installing small pilot projects in telecommunications to enrich the graduate studies in the department.

* Supporting the telecommunication sector with qualified human resources that are capable of comprehending new technologies and thus are capable of coping with the highly demanding and ever increasing new services.

* Narrowing the existing gap between the level of telecommunication services in the country and those available in other countries and helping the country cooperate economically with the western world.

b) Extension of the Management Department to a National Business and Management School

Management is a major problem in both public and private sectors. A project is being negotiated between HIAST and French and EC responsible authorities to enlarge the management department at HIAST to a business and management school. This project incorporates the following elements:

1- Undergraduate program leading to a Bachelor's degree in management or in business administration. This is a 5-year program.

2- Postgraduate program leading to a High Diploma in management or in business administration.

3- Continuous eduation program covering a wide spectrum of courses for both private and public sectors.

c) Creation of a Service Center for Technological Resources Open to Public and Private Sectors:

Scientific and technological resources present at HIAST, or those coming under the EU aid through the Second Protocol, will be grouped and offered as a common service for public and private use. This will have the following advantages:

- Increasing cooperation between education and research on one hand and industry on the other hand.
- Increasing the effectiveness of the use of these resources.
- Diffuse know-how to a larger sector.
- Improving the self-financing efforts of HIAST.
- Widening the practical experiences at HIAST.

The available resources will include facilities such as:

* The computer center
* Optics laboratories
* Material testing laboratories
* Automation studies and consulting
* Management consulting
* Scientific and technological library

Creation of a Network of Incubators

1- In order to create formalized and official relations between HIAST and the local industry, and to facilitate this relation through clear channels, HIAST decided to investigate the possibility of creation of a network of incubators.

Several visits to European experiments were organized. CAP ALPHA in Montpellier, France was visited several times by specialists of HIAST (Dr. Tabba, Dr. Mrayati, Dr. Khiami) and the director of this incubator came to Damascus twice. Another visit to the Chinese incubators associated with the Chinese Academy of Science were also conducted (Dr. Mrayati).

2- A project for the creation of a Technology Business Incubator was proposed following the workshop entitled "Creation of Indigenous Enterpreneurship and Opportunities for Small-and Medium- Scale Industrial Investment " held at HIAST in 1993 and organized by ESCWA, UNDP, ASST, and Friedrich Ebert Foundation. This incubator would be the first in Syria.

An agreement was signed between HIAST and the Damascus Chamber of Industry to cooperate to realize this project with the help of

ESCWA and UNDP. A study was conducted by an International expert. The main elements of the project are:

Purposes

The technology incubator is being installed as a joint project by the Chamber of Industry and the Higher Institute of Applied Sciences and Technology. The general purposes of this "second-generation" incubator program are:

* To nurture entrepreneurial small technology-related business to start and grow rapidly.

* To provide access to counseling on management, marketing, legal, accounting and trade/technology information to client-entrepreneurs in the incubator (together with affordable work space) and to others working in their own premises.

* To help develop new high value-added services and products, create self-employment and stimulate economic growth.

The specific purposes of the incubator are:

* To serve as the bridge between the Syrian technical research-education system and the productive sector (private and mixed public-private).

* To stimulate technological innovation, reduce dependence on former supplies of technical materials/spares, and introduce innovative goods, particularly in the quality management and environment fields.

* To link small businesses to medium-sized and large companies through subcontracting, spin-offs, and other arrangements.

* To attract foreign investments and technologies from Syrians living abroad, the Arab countries, newly- industrializing and industrialized countries.

Proposed Services:

The incubator management would provide the following services:

1- Affordable rental space.

2- Shared office facilities.

3- Tenant interaction.

4- Counseling.

5- Training.

6- Trade and technical information.

7- Combined purchases and marketing.

8- Access to investment and working capital.

Introduction of ISO 9000

One of the projects adopted by HIAST is to participate in the process of introducing ISO 9000 to Syria. The following action is taken:

1- Adoption of ISO 9000 within HIAST :

a) A Japanese expert on TQC, Mr. H. Yamaguchi, was dispatched to HIAST for two years within the cooperation program between JICA and HIAST.

b) A work team representing all departments was formed. The mission of this team is to apply this standard at HIAST.

c) a series of lectures on Total Quality Management, Productivity Enhancement, Total Quality Control Implementation, and ISO 9000 were organized and given by Dr. Adnan Aswad from the University of Michigan, Dearborn, USA, and by H. Yamaguchi.

d) A Quality Manual for HIAST is being prepared and printed.

e) A plan of work over /18/ months is established in order to introduce ISO 9000 (see figure).

f) A periodic review on quality control is published by HIAST and distributed to Syrian public and private industrial sector.

g) A number of video films on TQC, Zero breakdown, and ISO 9000, were translated into Arabic and being used in organized Syrian workshops and Seminars.

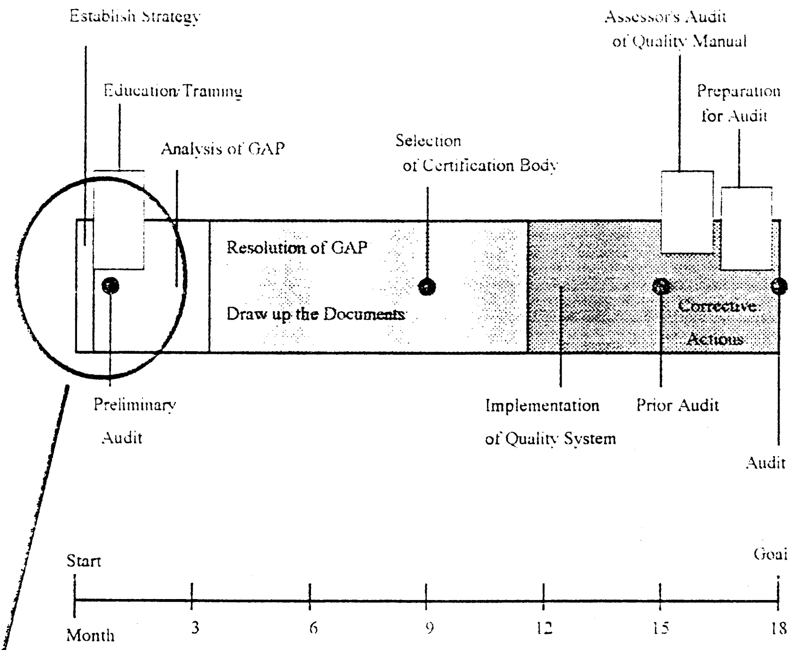
2- With the help of Mr. Yamaguchi ten Syrian public and private industrial companies were chosen to be studied with a view of improving their QC practices. Two of them have been selected for applying ISO 9000 to them. They are the pharmaceutical company TAMECO and the engineering Home Appliances company BARADA.

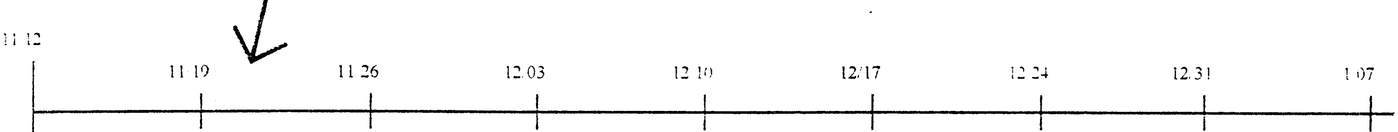
This program is facing some difficulties because of the lack of experience in this field in Syria. Some incentive to those working on this program should be adopted.

Creation of Companies

As a means of transfering know-How to its environment, HIAST is trying to create technological companies. Several steps have been initiated towards achieving this goal:

SCHEDULE OUTLOOK





Formation of
Project Team
- survey of
current Manual
- investigate
its validity
- identify
any shortage
any missing
any future plan

Sample of
Quality Manual
will become
available

analysis of GAP

start drawing up Quality Manual for HIAST

start making up Level 2 & 3 Manuals

Education/Training
- Video Tape x3 (30 minutes each)
(Understanding the ISO 9000 Standards)
- Books x9
-- How to draw up Quality Manual
-- Guide for Quality Manual
-- Checklist for Quality System
-- TQC vs ISO9000
-- ISO9000
-- Global approach for Certification
-- Examples of Quality Manual
-- Guide for Quality Manual
-- Guidebook for Registration

Initial
draaft of
Quality Manual

1- A feasibility study was performed.

2- Legislative action is sought to permit and regulate this action.

3- The first field found to be feasible from the point of view of the market and the capabilities of HIAST is software adaptation, Arabization and development.

4- A project of cooperation with UNIDO to create a "sub-Regional Application Software Development, Training and Marketing Center (RASTER)" is conceived in two phases. The first phase consists of creating a private or mixed company whose possessor could be HIAST alone, or HIAST with private partners. The principal objective of this company, named: SOFTRAC " Application Software Development and Training Center" , will be to work out and market turn-key solutions, mainly in the field of computer applications as well as application software development and to provide training on intermediary and advanced computer issues. SOFTRAC will also be a channel through which state-of-the-art software technology and related managerial techniques will be introduced to Syria.

The second phase is the establishment of RASTER on the basis of SOFTRAC. For details on the project several reports can be consulted [1] [2] [3].

5- Creation of other companies for optics and electronic products are being investigated.

Extention and activation of local, regional and International Cooperation:

HIAST is extending and intensifying its links at all levels. In addition to already existing agreements cited-above the following initiatives have been taken recently:

a) Education and research links:

- HIAST is proposing several projects, within the EC program INCD-DC
- An agreement with the German ULM University.
- Resuming cooperation with the British Council
- Cooperation with Cornell University- USA.
- Full financial and administrative partnership with the "Arab School on Science and Technology (ASST).
- HIAST became the Syrian Focal point for RITSEC- Egypt.

- Contact with the Arab Scientists & Technologists Abroad (ASTA)-to recognize HIAST as an educational focal point for ASTA in Syria.
- Cooperation with a EC-MED-Campus program to coordinate the curriculum of the DEA diploma on the MED level.
- Negotiation with (STE) Syrian telecommunication Establishment and SYRIANET company to form new engineers and reeducate already existing ones for them. This will be achieved with help from an EC program.
- Increase and activate publishing by HIAST researchers and teachers. Book editing is to be encouraged by incentives, an annual activity report will be published, better involvement in publishing of scientific articles. editing S&T video films.

b) Industrial and Commercial links:

- An agreement has been signed with the chamber of Industry of Damascus covering:
    * Training
    * Consultancy
    * R&D activities
- An agreement is being signed with the Syrian Ministry of Industry also covering training, consultancy and R&D activities
- Contracts with local public and private industries
    * Mahjoub company, evolution and automation
    * Almouasah hospital
    * Automation of sub-Systems in sugar factories.
- HIAST offered to participate in the EC program MED-INVEST.
- After the promulgation of law 49, the engineers graduating from Syrian Universities have to work for 5 years in a public establishment. HIAST welcomes about 15 of these engineers each year in its different departments.

Leaving HIAST at the end of the five years each one would have acquired enough practical know-how to facilitate their active participation in the local industrial and commercial enterprises. Several of them created their own small or medium size enterprises.

- Participation of HIAST in the UNIDO-Ministry of Industry project for the "Establishment of a National CAD Center for Engineering and Textile Industry. [4] DP/SYR/92/012/A/01/37.

Computer Managed Maintenance Systems (CMMS):

This project which started to be executed in 1995 and will last for two years is a UNDP/UNIDO aid with HIAST as a Focal Point.

Institutional Framework:

The project will be implemented by HIAST in co-operation with the Ministry of Industry. HIAST staff will be trained principally by working with the project experts in the installation of the system into the selected industrial plants and a transport company. HIAST will also be charged with the subsequent introduction, in consultation with the chamber of Industry, of the system into four other industrial plants. Through this later introduction of the system HIAST will ensure that the level of awareness of the importance of maintenance is raised through appropriate facilities available at institutions such as the Management Development and Productivity Center (MDPC) , the Institute of Industrial Maintenance, and the Computer Center at Lattakia University. The selected industrial plants for the introduction of the system, will be used as regional and "type" focal points for the training of personnel from other industries, both during and after the completion of this project. HIAST will coordinate with these industrial plants to further develop the extension of the service.

The introduction of the concepts of CMMS and the maintenance tradition into the educational/training programmes within the country will be the responsibility of HIAST, in cooperation with other appropriate institutions, during and after the completion of the present project.

Target Beneficiaries and Direct Recipients.

The Direct Recipients are as follows:

a) The National counterpart organization, HIAST in Damascus as the "focal point" for the National CMMS programme.

b) The Ministry of Industry.

c) Chamber of Industry, MDPC.

d) Seven Industrial plants and one transport company .

1. Objective 1

Enabling HIAST to become the national center for launching modern maintenance systems and to transfer the acquired experience, knowledge and understanding of all aspects of the Computer Managed Maintenance Systems to others through the programmes of assistance for the establishment of the CMMS in the selected industries.

2. Objective 2

Establishing and operating the CMMS within the 7 industrial plants and one transport company.

3. Objective 3

Establishing and sustaining of the "Maintenance Tradition" through the Chamber of Industry, MDPC, educational, and other institutions concerned with industrial production and development in the country.

4. Objective 4

Implementation of a proposed strategy for the development of industrial maintenance services capabilities in the Syrian Arab Republic.

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