AUTONOMOUS DIRECTION IN SCIENCE AND TECHNOLOGY

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Dr Sérgio C Trindade is Assitant Secretary-General of the United Nations, and presented this paper, his personal views, at a Foundation meeting at the Royal Society on 23 September 1987. The Lord Lloyd was in the chair, and the evening was initiated and organised by Dr Richard J. Haas.

INTRODUCTION

The oldest British alliance — now lasting for 600 years — resulted from the aspirations of the Duke of Lancaster to the Castilian crown, late in the XIVth century. John of Gaunt supported the illegitimate Prince João, the Grand Master of the Order of the Knights of Aviz, in the Portuguese succession crisis of 1383-1385. Lancaster found himself on the winning side, to which some 500 English long-bowmen contributed a bit, in the face of an invading Castilian army with reinforcements from France. The decisive engagement was the battle of Aljubarrota on 14 August 1385, a crucial event of the late Middle Ages in Europe.

To consolidate the birth of the long lasting alliance, Philippa, the elder daughter of John of Gaunt, was married to the victorious King João I, even before Papal dispensation was granted to the chastity-sworn Master of Aviz, on St. Valentine's Day 1387 in Oporto. Thus began the long reign of King João I of Portugal (1385-1433) and the dynasty of Aviz under which Portugal achieved world prominance during the XVIth century.

(*) The views expressed in this paper are those of the author.

A PROGRAMME OF RESEARCH AND DEVELOPMENT

The fifth offspring of João and Philippa, and the third to survive beyond infancy, was a unique Prince, known to the English public as Prince Henry, the Navigator (1394-1460). Prince Henry conceived and implemented what we could call today a long-term programme of research, development and demonstration in navigation technology, which included naval architecture, cartography and the art of navigation (1420-1460). This «programme» was a relatively concentrated effort to expand Portuguese power and influence, based on transfer, development and application of technology. It benefitted from a reasonable continuity of support — political, financial and otherwise — over a considerable period of time. This continuity was probably helped by the fact that Prince Henry had no aspirations to the Crown and was relatively neutral in the various successions he witnessed since 1433.

The motivations of this splendid Prince probably blended the pursuit of glory and religious exaltation — he was Master of the Military Order of Christ — in the continuation of the Crusades against the infidels and the financial benefits accrued from trade and colonization. At the time of his death in 1460, however, he was heavily indebted, but the Portuguese were only 26 years away from the memorable trip of Bartolomeu Dias to the Cape of Good Hope. They were by then getting ready to accomplish in a few years and for the first time, the round trip to India via the maritime route.

Thus, in 1497 when Vasco da Gama left Lisbon with his four ships equipped with three years' supply of provisions, modern instruments and considerable armaments, he was willing to take risks.

Da Gama was willing to take risks because:

(i) he was searching for his country a privileged position in a very profitable market: the spice trade that since times immemorial existed between the Orient and Europe was confined to restricted marketing channels that involved Indian, Arab and Italian merchants;

(ii) he was preceded by a long-lasting programme of research, development and demonstration in navigation technology that gave him and his captains unique and proprietary knowledge of the trade winds of the South Atlantic for their ships — the best ocean going vessels of the time — to sail safely and effectively;

(iii) he and his men displayed the military technology common to Europe which was at the time superior to that of the likely opponents in the Indian Ocean.

As a result of Da Gama's accomplishments and the epic work of Affonso de Albuquerque, the Portuguese Viceroy of the early 1500s, the Indian Ocean became for about 100 years a Portuguese lake. The strategic (still today) control of Malindi in today's Kenya, Hormuz Island at the entrance of the Persian Gulf, Goa and other points in the West coast of India, and Malacca in Malaysia, assured the Portuguese for about a century the control of the arteries of commerce. This expansion continued in the middle of the XVIth century into the China seas and reached Japan. Other Europeans followed suit and the era of modern colonialism began.

The puzzling question to pose is how could a tiny, poor and underpopulated country on the outer limits of Europe have accomplished the feat of opening up two thirds of the world to European commerce and of dominating for a considerable period of time that commerce singlehandedly? No single answer to this question is sufficient. But one important clue to the answer is the Portuguese determination to succeed.

DETERMINATION AND AUTONOMOUS DIRECTION

Determination, resolve and will to chart the future constitute the essence of autonomous direction on a societal, organizational and personal level. Thus autonomous direction in science and technology in practice means the ability to make reasonable decisions, including the ability to say no, in this area, in a relatively independent way.

At the country level, it results in considering needs, resources and priorities as perceived by the various relevant constituencies, and making reasonable decisions on matters of science and technology. Typical decisions involve options between transfer of technology and local development; concentration of efforts on socially and economically meaningful areas;

support to general and specialized education; improved information systems and communication, etc. In summary, autonomous direction at the country level implies the implementation of a national science and technology policy based on the consideration of issues and independent choice of options.

Modern and vastly sophisticated equivalents of the Portuguese technology policy of the XVth century can be found in Japan, after the Meiji restoration of the XIXth century; in India, once statehood was achieved; in Brazil and Korea over the last three decades; in France beginning with De Gaulle in the late 1950s; and in the People's Republic of China, particularly after the Cultural Revolution. In my view, all these cases contained a measure of autonomous direction.

At the corporate level, autonomous direction in science and technology involves the independent evaluation of the relevance of technology among key factors of success in the markets considered. Typical decisions involve options for instance between investing and disinvesting in specific technologies for a given market; acquisition of new technology via transfer from outside or in-house development; developing a totally new market for a new or existing technology. In essence, autonomous direction at the corporate level implies the implemention of a corporate science and technology policy based on the consideration of issues and independent choice of options.

If we stretch our imagination we can identify in the Military Order of Christ the corporate entity of the great navigations of the Portuguese in the XVth century. Current equivalents of the successful technology policy of the Military Order of Christ of the XVth century are present in the transnational corporations as well as in the emerging firms engaged in biotechnology, micro-electronics, new materials and new energies. I believe their success, to a large extent, can be attributed to their sense of autonomous direction in technology.

At the personal level, autonomous direction in science and technology boils down to the ability of individuals to choose among careers in a relatively independent way. Prince Henry, the Navigator, had a sense of autonomous direction in tecnology in the XVth century. Modern equivalents are numerous and include many inventors in science and a plethora of innovators in industry.

THE FEATURES OF AUTONOMOUS DIRECTION

Generally speaking, achieving a sense of autonomous direction is a political process. So it is in my view the process of practicing autonomous direction in science in the pursuit of knowledge, and in technology in the pursuit of economic rewards. It is my conviction that autonomous direction in science and technology can be characterized by a few common features such as political will, willingness to take risks and access to an information data base.

Political will is essential to support— financially and otherwise — a path into the unknown and to assure continuity in the face of possible adversity. It also helps to develop managerial and organizational abilities necessary for successful innovation, and in our days, invention. Prince Henry's caraveles failed miserably in many expeditions in search of the elusive Cape of Good Hope until they finally succeeded wth Bartolomeu Dias in 1486. Serendipity helps those who keep trying. Continuity of the process plays a key role in building up the infrastructure required for success at later stages.

Who would guess in the early 1950s, when Brazil's major export was coffee beans, that the British Royal Air Force would today be getting from Brazil airplanes to train its cadets? This Brazilian comercial success can be traced back to decisions taken 40 years ago. These decisions led to the setting up of aeronautical engineering education in the country, with emphasis on research; to the design of aircraft prototypes; to the establishment of EMBRAER, the airplane manufacturer; to the organization of subsuppliers of aircraft parts and components; to finding market niches for civil and military aircrafts in Brazil and in the world.

I believe that the political will that makes a difference is the one that provides continuity of support over an extended period of time, irrespective of political vagaries that might occur. The 40 years of navigation technology development of Prince Henry and the 40 years of the modern Brazilian aircraft industry are witnesses to that.

I think most people are normally reluctant to take risks. This is a natural self-defense posture. However, the processes of invention and innovation are very much dependent on taking reasonable (and sometimes unreasonable) risks. In an autonomous decision context, taking risks is

supported by the existing political will and by access to relevant information. There have always been cultures that are extremely cautious against taking risks. In my view, such societies find it hard to achieve a sense of autonomous direction. Vasco da Gama, at the close of the XVth century and Yuri Gagarin and Neil Armstrong, in this century, were willing to take risks, as they had political backing and motivation, and benefitted from a growing knowledge base behind their epic accomplishments.

The many failures of Prince Henr's caravels and the tragedy of the challenger are reminders that there are indeed risks in charting a course of autonomous direction into the future. Of course there are also commercial risks involved in seeking a measure of autonomous direction in a corporation. But success rewards only those who try.

It is evident to me that no country, corporation or person can follow a course of autonomous direction without access to relevant information and competence to utilize an evergrowing knowledge base. Thus access to scientific knowledge, which in principle is freely available, requires not only access to journals and electronic data bases, but, most importantly, the scientific literacy to understand their contents.

Access to culturally-bound, commercially valuable technological information today necessitates more than scientific literacy. It requires knowledge about markets, production experience and a minimum capacity in research and development. In short, a minimum infrastructure and experience. In all cases, education at all levels is essential to achieve today a sense of autonomous direction in science and technology. Of course, the relative importance of these factors has varied over time. Historically, technology has been quite disassociated from science. Empirically-based tecnology in the Middle Ages preceded science by centuries. Science-based technology is a relatively new concept.

I think we can now propose a new concept of technological independence. It is in my view the ability of countries, organizations and people to make independent decisions on the choice between acquiring technology by transfer or via their own development, to satisfy perceived or created needs. There is no technological self-sufficiency in the world. Hence autonomy does not mean autarchy. All countries buy, and many sell technology. Furthermore, there are very few countries which are net exporters of technology.

It is my impression that some sort of discontinuity — political, economic, social, technological and otherwise — followed by a period of a certain measure of stability, could be a contributing factor in achieving a sense of autonomous direction. Such discontinuities perhaps offer the opportunity for asserting direction, which, whether positive or negative, helps a course of autonomous direction in science and tecnology.

The consolidation of the kingdom of Portugal that followed the inauguration of the Aviz Dynasty clearly provided for a sense of autonomous direction. It also made possible the autonomous technological development that supported the great navigations and the opening of world trade and the world-scale colonialism that began in the XVth century. Similar processes can be identified in my view in the Meiji restoration in Japan, in post-war Brazil and Korea, in post-partition India, in post-Cultural Revolution in China, and even in De Gaulle's France.

In post-war Brazil, besides development of the aircraft industry, I could mention similar autonomous direction processes in electric power systems, oil refining, chemical processing, telecommunications, nuclear technology and computers. In all cases there has been political will, willingness to take risks, access to and competence in the utilization of relevant information. I might add that all these sectors benefited from expanded educational opportunities.

THE IMPACT OF TECHONOLOGY AND THE VALUE OF AUTONOMOUS DIRECTION

As technology is culturally-bound it can have profound implications in the lives of people, organizations and nations, when it is introduced in a new setting. Saint Augustine expressed amazement at the ingenuity and variety of the arts, yet feared that the good coming out of them may be counter-balanced by the evil of «so many poisons, weapons and military machines», in addition to superfluities and vanities.

The agricultural revolution in northern Europe that began obscurely in the VIth century and lasted 300 years had a profound effect on the geopolitics of Europe, as the centre of power moved gradually northwards from the Mediterranean basin. This resulted from the slow market penetration of new empirically-based agricultural technologies involving heavy

ploughs, open fields, triennial rotation of crops, livestock-cereal cultures combination, and the use of horse harness. The resulting food surpluses, and other factors, led to a considerable change in social organization and to a process of urbanization. The psycho-social anxieties derived from this process led to creativity, but also to aggression, such as the Crusades.

The drive of Prince Henry in his pursuits can be perhaps understood in a psycho-social context where the great navigations began as a crusade in the medieval tradition. The impact of technological innovation on international relations is therefore nothing new and examples abound in history. In such a situation a sense of autonomous direction can be in my view extremely valuable. It implies the capability to assess technology and science in a meaningful way and to maximize the net benefits obtainable from them.

The modern agricultural revolution — the «Green Revolution» — was based on scientific knowledge. It turned large, food-importing countries, such as India and Mexico, into food-balanced or food-exporting countries, and is affecting the international movement of grains.

Modern technology is evolving at a fast pace currently and is taxing the capacity of humankind to cope with change, but it is doing so unevenly, as the gap between developed and developing countries widens. This is a major cause of concern as it affects peace, stability and equitable development among nations.

THE TECHNOLOGICAL CHALLENGES OF THE FUTURE

We have hardly finished the colonial era on earth at a time when colonization of outer space has already begun. The new and emerging areas of science and technology — NESTs for short — offer challenges to all countries and opportunities to a few countries who know what they want, that is, who have a sense of autonomous direction. Given the widening gap between groups of countries, the NESTs pose a significant challenge to developing countries. How can a least developed country benefit from the NESTs in the autonomous mode? What will be the geopolitical shape of the world in the future in the face of the NESTs? Can peace, stability and equitable prosperity be ever achieved in the world? Is there any assured formula for successful development of any social and economic system?

There are no simple answers to these troubling questions. But I cannot visualize a peaceful, stable and equitably prosperous world without all countries achieving a certain sense of autonomous direction. This achievement implies the reduction of gaps and constitutes in my views a pre-condition for an improved partnership among nations.

THE ROLE OF THE UNITED NATIONS

Peace, stability and equitable prosperity are the ideals pursued by the United Nations since its organization 42 years ago. If these ideals are realized the world would evolve into a community of nations in genuine partnership.

Despite the criticisms on the efficiency and effectiveness of the organization, it is my belief that the ideals of the United Nations remain valid. The UN system has expanded considerably over the years and is composed of the UN proper, the United Nations Development Programme — UNDP, and the specialized agencies, including the International Monetary Fund — IMF, and the World Bank.

In 1979 a conference on science and technology for development in Vienna led to a focus on this topic in the UN. Consequently the following bodies were established: an Intergovernmental Committee of all member states; a Task Force of all the interested agencies; an Advisory Committee of 28 eminent people from all over the world, a Financing System (now a trust fund within UNDP), and the Centre for Science and Technology for Development — CSTD. They were all established to implement the core-decision of the Vienna conference, namely the growth of the endogenous capacity of developing countries. To me, endogenous capacity is the ability to practice autonomous direction in science and technology at country level.

The work of CSTD is thus concentrated in helping interested countries build endogenous capacity. CSTD is joined in this endeavour by the relevant members of the UN system. This is of course a long term proposition. But it can be expediated by policy dialogues at a national level, where the various interested constituencies must be involved in order to bring science and technology into the mainstream of their social and economic

life. These dialogues, in which CSTD plays the role of a catalyst, are carried out by people in the countries concerned, and are expected to yield a portfolio of priority actions that should reflect needs, resources and priorities as perceived by the countries themselves. We are just beginning this exercise on an experimental basis in Nepal and planning it for Tanzania and Colombia, with financial support from a few donor countries. If the experiment proves its worth we would like to expand the programme for which additional donors would have to be engaged.

This approach should be of interest to all concerned, recipient countries, donor countries and the UN system. If it works it would make it clear and explicit, in the autonomous direction mode, the path selected by the recipient countries in making use of science and technology for their future development.

Another activity of CSTD, which is part of endogenous capacity building is the advance tchonology alert system — ATAS. In the ATAS exercise specific NESTs are assessed by a group of international experts, results are disseminated in bulletins and other media, and their national and regional relevance is interpreted with the help of a core technology assessment network and networks specialised in the NESTs analyzed. So far tissue culture, automation, informatics, technology assessment proper, and new materials have been studied in the ATAS context.

CONCLUSIONS

Inequities in the human conditions and among nations must be eliminated if the ideals of the United Nations are to be realised. I am perfectly aware that autonomous direction is not entirely a new concept or that it provides by itself a sufficient condition for happiness and fraternity among humankind. After all, developed nations by and large do possess a sense of autonomous direction. But I do believe that the community of nations will live better and survive if the nation-partners stand on a more equal footing, and particularly if the gap within and among countries shrinks. Endogenous capacity, or if you prefer, autonomous direction, is a necessary condition for developing countries to realize that goal.

Why can't human conflicts is resolved without resorting so often to war and aggression? Are war and aggression inherent to human nature?

Is humankind a prisoner of the natural cycles of creation, nurturing and destruction of the Vedic tradition? Unfortunately, I don't have answers to these crucial questions. But the overwhelming historical evidence is against my vision and my belief that the world and humankind that lives in it can be both beautiful and worthwhile. Ultimately, human conflicts are about power and its control. And many have said before me that knowledge is power. Thus science and technology contribute to power, political and otherwise.

Peace is thus related to the management of power and just as we are in principle against monopolies in the economy, we should be against the monopoly of power by nations. It is my belief that the world would be better off if the power were more evenly distributed among nations. And autonomous direction in science and technology in all countries is a necessary condtion to achieve this desirable goal.

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