# THE UNCHARTED ROAD TO GLOBALIZATION

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*I have been privileged throughout my career, since the 1950's in fact, to be part of the community of international research, science, technology, the new community of those who came to play a most significant role in the post world war II global industrialization. Other than for teaching on both sides of the Atlantic, I have maintained a close relationship with the emerging network of international scientific associations that were created to bring together professionals concerned with those new tools related to computers and applied mathematics that have become essential to practically every aspect of science and technology. The most pleasant part has been in meeting with many colleagues, members of that community, encounters on the occasion of perennial committee meetings or scientific conferences. Subjects of informal discussions (and most informative because of their informality) have - in particular when in Europe - often been about comparisons with the US in matters of research, education and industrial development. And as of late, predominantly with questions related to globalization . What I became very much aware of is not only of the wrong image different groups in that community may have about others - and often their own - but also of a fragmentation of cultures within the learned population leading to a pervasive lack of perception of what lies behind the momentous changes that are taking place on the inevitable path to globalization. Which raised my interest in writing some of this down, perhaps for myself as much as for others.*

*Gathering information was an interesting experience in itself. I came to realize that the term applies to a number of different things, even limiting myself to those that have a clear relationship with the world's industrial development . There is on the one hand a body of information one may call "official", that which concerns capital, finance, statistics and their interface with politics, that given out by governmental institutions, generated by think tanks, published by the press, available on demand. Then comes another which by contrast with the former concerns science and industry, things that actually do take place in academia, in research laboratories, in factories, discussed in corporate boardrooms. That information*

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*is notoriously harder to come by, not prepared for distribution, incomplete, with lapses brought about by the fact that much of it relates to what is done under the aegis of private business, of multinational corporations that have become a powerful component in the world's development and that are loath to talk about what they do. But the former, the "official" information that implicitly pretends to be complete is not complete either, and by far. In addition to being influenced by their professional and political environment, its authors are often specialists, the information they provide is compartmentalize, looking at one question at a time, ignoring interactions with related subjects, those very interactions that happen to characterize the very essence of what is happening in the new game of globalization.*

*What this division reflects is the existence of two world, of two cultures, on the one hand, those attached to what I have called the "official" picture of globalization , on the other those engaged in research, innovation, global industrial development. The two reside in ideologically separated communities with their own agenda, contributing each in different ways to the path taken by globalization but intrinsically with little coordination or cooperation taking place between the two.*

*I have in writing what follows and for obvious reasons tried to limit myself to the science and industry side (which is where I belong). What emerges is a story of development, of globalization significantly different from that close to economics and politics, that reported by the press, that seen by the public. There is a difference of substance : the story that looks at the science and industrial development side consists of actual events, while the other, the "official" often describes cause and effect between facts and opinions that are left open to debate and subjective interpretation. And there is a difference in time scales. The science-knowledge-industry side is metaphorically more in the vein of long term strategy, while the other is closer to short term tactics, entangled with politics.*

*I realized, in the process of writing those things down, that many of the ideas coming to mind were coming from fragments of information gleaned on the occasion of those informal discussions, conversations with colleagues I mentioned, putting light on a large body of otherwise undocumented, little talked about information, in particular that concerning things that fall between the two cultures - or that should involve both. And there are many of those things taking place. In addition to colleagues, I should also mention present and past students, part of that new international , mobile, community of educated young (and some not so young) men and women, post-docs, researchers, faculty who with few exceptions have traveled, migrated from one country, from one continent to another, bringing with them not only the classical knowledge that is part of their scholarly training but also personal observations that tell much about the human element in the story of globalization.*

## *knowledge*

The picture of globalization seen by the public is mostly concerned with economics and trade, illustrated with such tangible things as goods, capital moving around the world, jobs exported overseas. But this is only part of the story. If only as attested by the title *"Building Wealth : the New Rules for Individuals, Companies and Nations in a Knowledge-Based Economy"* given by the M.I.T. economist Lester Thurow to one of his recent books[2], knowledge has come to be possibly more important than capital as a force contributing to the world's development. Much of what has taken place in industrial and economic growth in the period following World War II has been related to knowledge, somewhat of a repeat of the scientific revolution of the 17th century that gave rise to the industrial revolution of the 18th - assisted this time by the emergence of computers and information technologies that brought to the human intellect what James Watt's steam engine had done to physical labor. With good reason, today's period in history has been called the second industrial revolution.

While knowledge and economics are both important in influencing the manner in which globalization is taking shape, economics has traditionally been what governments are concerned with, and official intergovernmental organizations have been promptly instituted to assist, control and regulate global finance and trade - the International Monetary Fund and the World Bank (1944), the General Agreement on Tariffs and Trade (1947) , the Organization for Economic Co-operation and Development (1961) to name a few. But no such governmental regulatory presence is to be found in matters that concern knowledge, the essence of a culture that has a life of its own and that does not, as a matter of principle, admits external control or restrictions. The community where it resides is populated with academics, scholars and industrial scientists. It is pretty much self regulated, selects its own peers, organizes its activities, conferences, publications within a somewhat informal network of professional societies closely related to academia. This was illustrated by the appearance, when the need arose, of new international scientific associations established from within the community to bring some coordination in a new world of emerging disciplines related to the mechanization of knowledge, the application of computers and information technologies to almost every aspect of science and technology. There were by order of appearance IMACS[3] (Scientific Computing, 1956), IFAC (Automatic Control, 1957), IMEKO (Measurement, 1958), IFORS (Operations Research, 1959) and IFIP (Information Processing, 1960). The "Five

[2] Lester Thurow - Harper Collins 1999

[3] IMACS was originally incorporated as AICA, the International Association for Analog Computation. Change to the present name was made in 1976 - to reflect the evolution in the technology of electronic computing that had taken place in the intervening years.

International Associations Coordinating Committee" (FIACC), a committee intended to facilitate cooperation between them was created in 1972 under the aegis of UNESCO.

It is interesting to reflect on the fact that while monitoring, controlling trade, the flow of capital is a fully accepted process, practiced by governmental bodies, interference with the flow of knowledge (excepting that which is protected by patents as "intellectual property", that kept as trade secrets[4] or that which may have strategic applications such as chemical, nuclear or biological materials[5]) would be unfeasible, considered as undemocratic. Worth noting in that respect is that while UNESCO - as is the case for other organizations with similar objectives - provides advice, financial and other material assistance, but does not have authority when it comes to deciding, judging on scientific, on academic matters, deciding as to what shall be published or not in a scientific journal. Attempts to limit the publication of scientific results, the travel of scholars - things that are done at times for political reasons[6] are vigorously opposed by the scientific community and its strong representation in academia, an establishment whose traditional principles are before all those of freedom of expression and free flow of ideas (I was privileged to have my picture make the front page of a leading Oslo newspaper for affirming that position on the occasion of an IMACS Congress held in that city in 1985).

[4] As an example, the know-how behind silk production was kept secret for some 2000 years in China, and it was a capital crime to export live silk worms.

[5] of which I was reminded by Jean-Pierre Contzen.

[6] in *"Le Monde"*, March 6, 2004 : "L'administration Bush restreint la liberté des revues scientifiques" : the Treasury Department has requested some 30 editors to ask for a preliminary authorization before any scientific publication coming from a country under embargo (Sudan, Libya, Iran, Cuba, North Korea) - it is reported:

## *industrializing the world*

The world's population that had started growing sensibly a couple of centuries ago with the beginning of the industrial revolution was only more on the increase after the war. Travel and transportation had become easier, bringing together communities that had so far been separated, relatively self sufficient and autonomous but were no more. Globalization was inevitable. The only unknown was how it would materialize itself.

Large differences in industrial development and economic conditions across the world became visible. These differences were not new. What was new was the emerging power of communications letting everyone on Earth potentially informed, letting the rich feel responsible for the poor. Reflecting this, the charter of the United Nations signed in 1945 included wording toward the elimination of differences, promising freedom from want. A 1949 report to the General Assembly said that 1.0 percent of the gross product of the industrialized countries given in economic assistance would see the underdeveloped countries to self-sustained industrial development by the end of the century[7].

An economic infrastructure for globalization had been initiated with the Conference at Bretton Woods, declaring in 1944 that *...broad international action is necessary to maintain an international monetary system which will promote foreign trade"....* recommending the creation of the *International Monetary Fund* and the *World Bank* (sometimes referred to as the Bretton Woods twins).

But it is interesting to realize how far today's brand of globalization differs from what was in the air at the time. The proper name of the World Bank was *"The International Bank for Reconstruction and Development"*. The last part , *"development"* was added almost as an afterthought. At the time, most of the countries in the developing world were still colonies, and what meager economic development efforts could or would be undertaken were considered the responsibility of their European masters[8].

The *General Agreement on Tariffs and Trade* (GATT) signed in 1947, was ..

> *.....designed to provide an international forum that encourage free trade between member states by regulating and reducing tariffs on traded goods and by providing a common mechanism for resolving trade disputes"* [9], [10], [11].

This message was repeated by social philosophers and commentators who ventured to predict that extending the benefits of the experience and knowledge acquired in the industrialization of the West to the rest of the world was only a matter

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[7] G. Piel, - communication to the "Sixth Olympiads of the Mind" Paris, 2002
[8] Quoted from Joseph Stiglitz, " *Globalization and its discontent* " Allen Lane/Penguin 2002
[9] see www.ibiblio.org/pha/policy/1944/440722a.html
[10] http//www.oecd.org
[11] from the GATT web site : www.ciesin.org/TG/PI/TRADE/gatt.html

of determination. Which may be illustrated by quoting the British scientist turned philosopher C.P. Snow :

> *"..... We cannot avoid the realization that applied science has made it possible to remove unnecessary suffering from a billion individual human lives- to remove suffering of a kind which, in our privileged society we have largely forgotten, suffering so elementary that it is not genteel to mention it. For example, we know how to heal many of the sick: to prevent children dying in infancy and mothers in childbirth: to produce enough food to alleviate hunger: to throw up a minimum of shelter: to ensure that there aren't so many births that our other efforts are in vain. All this we know how to do. ..... And it does not require one additional scientific discovery....."*

and that this would happen was a matter of inevitability :

> *" …. There is no other way. ….. When it is achieved, then our consciences will be a little cleaner[12]"*…….

All was well, at least for the US which was at the time - in part as a byproduct of the war - by far the most developed democratic country in the world. John Kenneth Galbraith was publishing *"The Affluent Society"* (1958), citing as a future problem that of keeping affluent populations occupied. The Hudson Institute, a think tank founded by members of the Rand Corporation published a 1000 pages report predicting life in the year 2000. One of the predictions was that by the end of the century Americans would have 13 weeks of vacation, 147 work days and 218 free days a year. It was somewhat less optimistic for the rest of the world, but it would be only a question of time before the benefits of western style industrialization would get there too [13]. And Europe was on its way to reconstruction, with the assistance of the Marshall plan.

With good intentions and without much thought as to how this would play out in the long run, the West took on the task of literally exporting its own brand of industrialization to the rest of the world.

But things did not exactly turned out as planned.

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[12] in C.P. Snow *"The Two Cultures"* - 1959 and 1964, Cambridge University Press

[13] cited by J.J. Servan Schreiber in *"The American Challenge"* (1968), Avon Books.

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Industrialized countries had in modern times consisted of three essential components:

-- a research/development/manufacturing establishment,

-- an academic, university educational system,

-- human resources, beginning with young generations willing to be educated, willing to become those scientists and engineers needed to keep the system going.

Those were by necessity located close to each other, often within the same national borders and with limited interactions with their geographic neighbors. There had been before World War II reasonably well identified industrial nations, the American, the British, the French, the German - to name those that are most visible in today's developed West - and (with due apology for others I am not citing) there were significantly Russia and Japan.

It must have been implicitly assumed, no doubt by default, that globalization would materialize itself in the form of a world wide distribution of reasonably autonomous, self sufficient regions where all classes of the local population would lead satisfactory material and cultural lives. At least nothing else was envisioned at the time. But as the media guru Marshall McLuhan said, the nature of a new device (and knowledge, science, global communications and transportation were indeed new devices), the nature of a new device is usually not truly understood until it has been around for some period of time. And so it has been. No one seems to have predicted (as late as the 1960's, may be later) that a consequence of the reduction of restraints imposed on travel, of relaxed regulations on international finance and trade that were meant to facilitate commerce, the flow of capital and goods across borders also meant that those essential components of a same industrial enterprise could now be located apart from each other, on different continents. It had not been foreseen that instead of the old cliché of autonomous industrial communities having locally their own educational, research and manufacturing facilities, it would now be possible to have these components be geographically separated, raising what turned out to be the unhealthy possibility of having within the same private corporation those seeking financial profit and those doing the work located on different continents, in countries with different economic status, subject to different labor regulations, under the supervision of different authorities.

But this is precisely what has taken place. Driven by a Darwinian kind of evolution more so than by any of the officially formulated plans, with factors including the presence of human resources, of markets and profit seeking capitalism near the top of the list, globalization has materialized itself with research, manufacturing,

education moving across borders, rearranging themselves unevenly around the globe, with distributions that change moreover now and then with the whims of politics and economics, sometimes with entirely unwelcome consequences[14].

There have inevitably been winners and losers. Problems encountered by the losers are occasionally described as the normal course of events by those who are concerned with planning industrialization at the global level. But this ignores human factors at the local level. Losing is far from "normal" when experienced by countries where entire segments of the population whose job has been moved elsewhere on Earth are left unemployed, impoverished, unhappy.

Prompted no doubt by the wake up call of massive protests against globalization that began around 2000[15] (several decades after globalization had started, one may note), economists, those formally charged with steering it have had to recognize that something in what they were doing had to be changed. A good description thereof is given in the 2002 book appropriately entitled "*Globalization and its Discontents*" by Joseph Stiglitz, Nobel Prize laureate and former Chief Economist of the World Bank, where we find in the preface, after mention of the damaging effect of globalization on the poor in developing countries :

... "*I believe ... that ... the way globalization has been managed, including international trade agreements that have played such a large role in removing ...barriers.... need be radically rethought*" [16]

But there is more to globalization than what can be improved with management, trade agreements and economic measures, as Stiglitz would tend to suggest. The path taken by globalization has been affected more significantly - though quietly - by things that are closer to human behavior, such as the education by the West of foreign workers, engineers, scientists, the transfer of know how, of technology from one continent to another, eventually the migration of entire research facilities that came with the internationalization of industry. What used to be national companies, mostly American at first, extended their territory, transforming themselves in multinational corporations. This led to the rise of the vast private, international industrial establishment that has become a most, if not the most important force influencing the path taken by globalization - an establishment influenced behind the scenes by politics sometimes in no small way as recent world events have shown.

Most significantly, the final result has been a migration to other continents of much of that body of scientific knowledge, of industrial know how which had historically resided in the West where it saw the light between two and three centuries ago, that very knowledge which had (with Europe at first) given the West, the North Atlantic its global superiority for those few centuries.

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[14] I heard Bill Joy explain that *evolution* instead of *planning* was also the rule in technological progress, which may well have something to do with the title "*Why the future does not need us*" given to one of his papers (in "Wired" - April 2000)

[15] one of the first was the large scale protest at a meeting of the World Trade Organization in Seattle, December 1999

[16] Joseph Stiglitz, , (2002) op. cit

## *the two cultures*

What the preceding brings to the fore is the little talked about, little realized fact that those who are influential in the world's development are segregated in two separate cultures, on the one hand those concerned with economics, politics, by and large attached to governments or governmental organizations - on the other those involved with science, research, industry. While both essential in contributing to the process of globalization, they have each their own agenda. But, by their very nature, not much collaboration, coordination is (nor will soon be) taking place between the two.

When C.P Snow presented his famed *"Two Cultures"* lecture at Cambridge in 1959, he was talking of literary intellectuals versus scientists, of the irreconcilable gap that separates them[17]. By contrast with Snow's two cultures whose separation had no more than academic, philosophical implications, today's two cultures are both essential to the process of globalization, they both participate in developments that impact on the well being if not the very life of populations on the entire planet.

This two cultures syndrome manifests itself in a variety of ways. There is for instance a difference in the way members of each are looked upon, what impact they have on public opinion. About which I may recount a personal experience : It was in the late 1950's and we, a group of alumni engineers of the Brussels Free University (very much part of the "knowledge" culture) had invited Paul-Henri Spaak (our colleague- law graduate form the same university) at a dinner to give us an overview of the Treaty of Rome that had just been established under his leadership, establishing foundations for the European Community. When after the talk one of us (it was André Jaumotte[18]) noted that *"we, engineers, have effectively functioned as an international community for years, well before this treaty"* (our school had, among other things, been that forming the cadres responsible for bringing electricity and streetcars to cities all over the world) responded Spaak *"Yes, may be, but it had to wait for us* (policy makers from governmental institutions, not members of the science/engineering community) *to actually implement it"*. What he implied was that only after signature of the treaty would the *"Community"* officially begin to exist, be on public record, that its appointed representatives would have to be listened to on the international political scene, reported by the press. And not before.

Another aspect is in the way economists and political commentators have a poor understanding of the role of science, missing essential points. I found a typical

[17] C.P. Snow *"The Two Cultures"* , op.cit.
[18] I had the occasion to meet recently with André Jaumotte – who told me remembering as well as I did, almost half a century later, this exchange of ideas.

example in Paul Krugman's recent book entitled "The Great Unraveling"[19] where we read : *"...I was amazed to hear the group condemn Japanese companies as uncompetitive , unable to manage, unable to focus on the bottom line. But surely it can't be true of all Japanese companies; guys who manage to export even at 80 yen to the dollar must have at least a few tricks up their sleeves"*. Which is only about economics and management. But that the performance of Japan may be related to its technical, its scientific accomplishments, something engineers and scientists consider as essential is not even mentioned. That the world's most powerful computer in 2002 was produced by Japan is not mentioned. That color television invented in the U.S. in the 1930's had Japan become one of its most advanced developer and producer is not mentioned. And that Toyota has become the largest car producer in the world, just about to beat Ford as the second largest car producer in the U.S. (based as much, if not more on engineering performance than managerial know how) is not mentioned either. Nor is the fact that Japanese high school students are rated near the top of the list in global rankings of performance in mathematics and science[20]. The paragraph ends with more management and economics " *...And wasn't it only a couple of years ago that Japanese management techniques were the subject of hundreds of adulatory books and articles?. They were never really that good, but surely they are better than their current reputation"* . Krugman is before all an economist and mixing science with economics is something economists as a rule do not do.

Significantly, relevant information coming from the science/knowledge community is all too often ignored, not taken into account by policy makers when it really should. There is for instance the case of what was referred to at the time as *"World Dynamics"*. Studies based on computer simulations had taken place in the late 60's - early 70's, conducted at first by Jay Forrester and collaborators at the Massachusetts Institute of Technology under the instigation of the *Club of Rome* that had initiated a project on *"The Predicament of Mankind"*[21]. What was predicted is, among other things, that if nothing was done to put it in check, the increased population on Earth would by the year 2010 or so bring about major problems to mankind such as a scarcity of natural resources and excessive pollution[22]. Yet, with few exceptions, (in particular China - but China does not have a democratic government and action at the global level may only be implemented by democratic process) very little has been achieved at the international level. The World population has almost doubled, much of it in the wrong places. Shortage of water, global warming created by carbon dioxide in the atmosphere, poverty in mega-cities and elsewhere as examples, have shown up almost on cue some 30 years later. The lack of connection between the information that existed on the one hand, the absence of response by official organizations on the

[19] (2003)
[20] The U.S. are coming way down the list, somewhere in 15th place - see fig 22 below.
[21] See Jay W Forrester *"World Dynamics"* Wright Allen Press 1971
[22] Two of the books summarizing the results of these studies at the time have the revealing titles of *"Limits to Growth"*(MIT) and *"Models of Doom"* (Sussex).

other was revealed when the United Nations organized in August 2002 a widely attended *World Summit on Sustainable Development* in Johannesburg whose main theme was to address the multiple, mostly human, environmental, health problems brought about by overpopulation. Yet, not a single session, not a single paper was devoted to the question of overpopulation, population control and the like. These are touchy subjects, one has to recognize, but just the same. This was much decried by members of IIASA (the International Institute for Applied Systems Analysis located in Laxenburg, near Vienna, Austria) - where the kind of studies started by the *Club- of-Rome-Forrester* in the late 1960's are still conducted today. A letter of protest written by IIASA's W. Lutz and M. Shah entitled "*Population should be on the Johannesburg agenda*" was published in *Nature, July 4, 2002.*.

It is worth noting that the chasm between the two cultures runs deeper than just that between the theoretical concepts of economics and knowledge. Take for instance professional ethics. Plagiarism, false statements issued by members of the scientific community, even when revealed during peer review processes before publication may result in a virtual blacklisting of their authors by the community. There have now and then been cases of eminent (and a good number of less eminent) scientist having their career permanently downgraded because of such occurrences. But inaccurate statements made by members of the economics/political culture are common place, taken in the vein of "business as usual" (think of the rhetoric of pre-election campaign speeches), and professional damage to their authors is minimal, temporary at best.

## *unforeseen developments*

*Plans for extending the benefits of industry and wealth to the rest of the world that were formulated by the West in the 1940's, the 50's , even the 60's - those of the Bretton Woods Conference, the United Nations and many others were overly simplistic, if not naive. Industrial research, scientific innovation were given marginal attention, considered as quantities with little will of their own, other than for being expected to somehow produce useful science and technology in response to financial stimulus that was to be forthcoming. And workers from outside of the Atlantic North were considered as not much more than hired labor. Planning for the future was to be done with economics, managing international finance, controlling trade. But, as we have seen, knowledge has in the meantime come to be most important in the process of industrial development. Globalization involves people, scientists who are given options. It involves research and development by private companies with their own financial objectives - things that fall pretty much outside of what governmental organizations control. Unforeseen turns of events were to inevitably come about. And they have, such as:*

*--- those related to human attitudes, in particular the unexpected response of young generations to possibilities and career choices offered to them.*

*--- the actions of private business, the growth and multiplication of multinational corporations often accused by the public of being guided by greed, but labeled as no more than applying the rules of good management by the financial community, by that part of the media illustrated by The Wall Street Journal or the Financial Times.*

### *losing the young*

Of things not only unpredicted but apparently ignored altogether in the early days of what we now call globalization, one that has contributed significantly to unexpected directions came from the fact that young men and women in the wealthy, developed countries (those very countries that were to serve as examples for industrializing the rest of the World) grew to a large extent out of the natural sciences picture, distracted, not much interested in research and engineering careers. What this young generation sees its social environment and the media laud (and with modern communications, not exclusively in the West) is more often than not associated with business, finance, "life on the fast track" as the expression goes. And in a sort of intellectual Luddism, when the media show scientists it is, if not as nerds, more often than not as bad guys, those responsible for environmental pollution or some other ill, depriving in the process

the young from exposure to a healthy set of role models. So management, business administration, law, the political sciences and similar disciplines have to a large extent replaced the hard sciences and engineering in the list of educational choices. Not to mention the fact that salaries may be better, it is also the case that the educational process leading to occupations in those fields is significantly less demanding than that leading to the natural sciences and engineering. And - to a degree by reaction - some of the young turn to the social sciences and the liberal arts, philosophy, religion, showing interestingly an attraction by extremes away form careers in the conservative center on the employment scale .

The consequences came to be most visible at first in the US, the epitome of this new world of science and technology. The government had for strategic reasons taken steps toward increasing the scientific potential of the nation by generously funding research and science education. This had been initiated under President Eisenhower in response to the launching in 1957 by Russia of Sputnik, the first man made satellite. Other than NASA, one of the outcomes was DARPA, the Defense Advanced Research Projects Agency[23] established in 1958, an agency that plays a significant role in funding the development of advanced technology, computers and related sciences with a current budget on the order $2.5 billion a year, responsible among other things for creating the Internet. But a few decades later (more or less in the late 1970's, after the Apollo space program had ended and the Vietnam war had left the public with a bad taste in the mouth about the ethics of the great American industrial-military establishment) the country was to find itself faced with an undersupply of young Americans willing to enter scientific or engineering careers.

Things were different in other parts of the world, in particular Asia where an education in science and technology, especially when backed with an American diploma, was perceived as leading to personal success and better living conditions. Surrounded by a different environment, exposed to different role models, less distracted by things brought about by wealth, and some presumably encouraged by governments that must have seen the light coming from the West, many among the young were choosing the natural sciences and engineering as the focus of their education, as their interest in life. Permissive immigration laws in the U.S. combined with other factors including the ease of travel did result (quietly, without fanfare) in that empty benches in graduate science classes came to be filled with students coming from abroad , many from China and India.

There were some 600,000 foreign students in the U.S. in 2002 . They represented (and had for a number of years) a majority in many of the graduate classes in the natural sciences and engineering. The ethnic shift that had started with student populations was of course followed by a similar situation in the entire research, development and to a lesser degree manufacturing establishments. The demand for

[23] www.darpa.mil

scientists in governmentally funded research as well as in industry, the demand for faculty and researchers in academia led to many of those foreign students taking jobs and staying in the US after graduation, many of them eventually becoming permanent residents, American citizens. They liked the idea in the first place, material conditions being better than at home, this to the disappointment of the government of their native countries that were to find this out *post facto*, having expected them to come back home with their newly acquired degrees. Statistics show that more than eighty percent of Chinese and Indian students getting Ph.D.'s stay in the US[24]. Talking of Ph.D.'s, Lester Thurow notes that in the U.S., a college education is of little value if not followed by the completion of a graduate degree program[25]. This is precisely the kind of degree fewer American but more of those foreign, visiting students are getting[26].

**Figure 1**

**Table 3. U.S. engineers, by highest degree in any field, native-born status, and age: 1995**

| Age (percent) | Highest degree in any field[a] | | | | | |
|---|---|---|---|---|---|---|
| | Native born | | | Non-native born | | |
| | Bachelor's | Master's | Doctorate | Bachelor's | Master's | Doctorate |
| Under 30 | 85 | 14 | 1 | 59 | 40 | s[b] |
| 30-39 | 73 | 24 | 3 | 46 | 41 | 13 |
| 40-49 | 66 | 30 | 4 | 44 | 42 | 14 |
| 50-59 | 61 | 33 | 6 | 47 | 40 | 13 |
| 60 and over | 75 | 19 | 6 | 49 | 38 | 13 |
| Total | 71 | 25 | 4 | 47 | 41 | 12 |

[a]The highest degrees of about 8,000 engineers did not fit into these categories.
[b]Suppressed due to small cell count.
**SOURCE**: National Science Foundation/Division of Science Resources Studies, Scientists and Engineers Statistical Data System (SESTAT), 1995.

*Of graduate students who study in the U.S. , those foreign born are more than twice as likely to pursue their studies to the Ph.D. – likely to end up higher up in the ranking of scientific researchers.*

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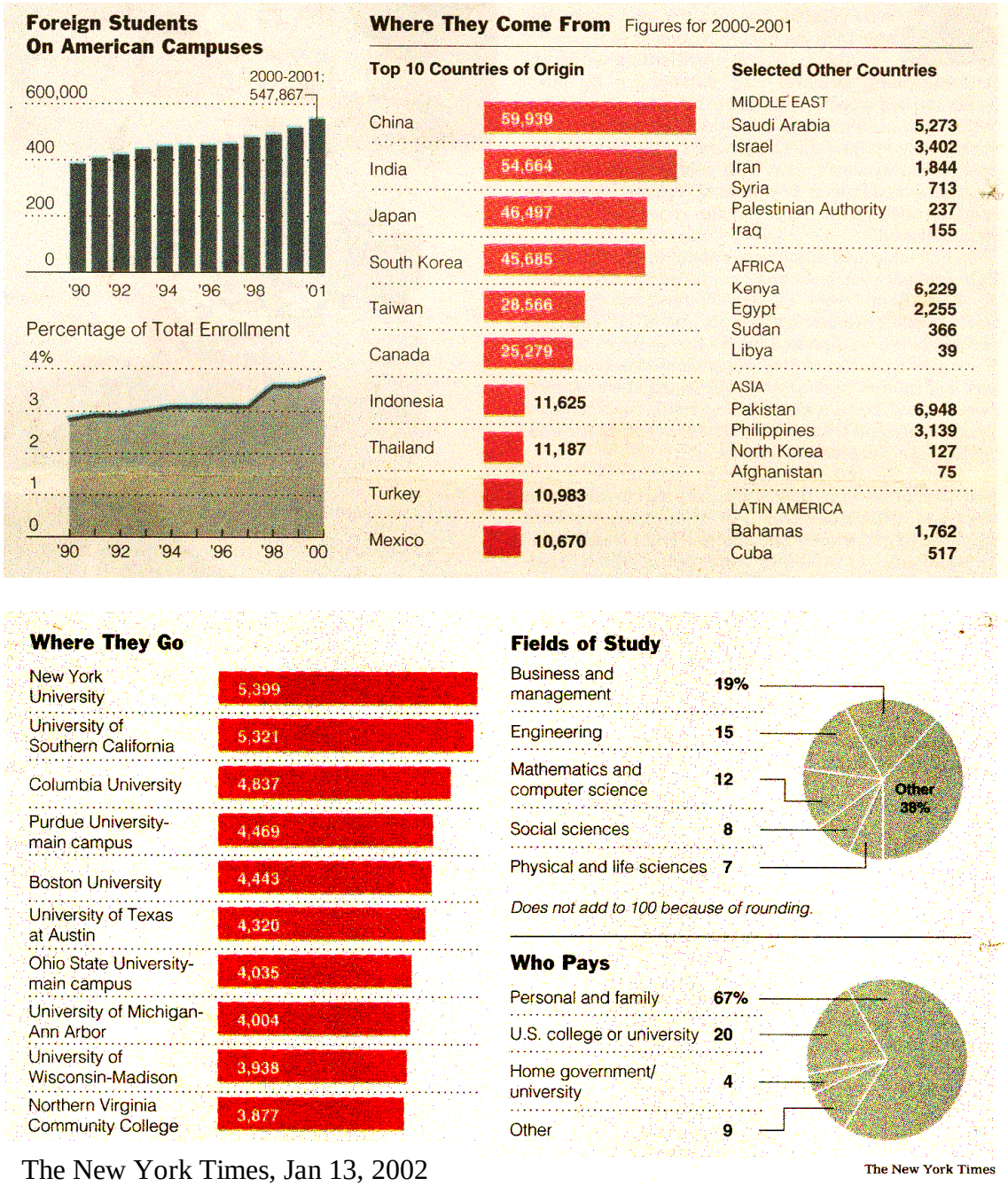
[24] *"Outward Bound"* in *The Economist* , Sept. 28th 2002
[25] Lester Thurow op. cit.
[26] *"Is Science Policy at Risk" Brookings Review,* v 19, n 1, winter 2001

Figure 2




The New York Times, Jan 13, 2002

### *going away I : outsourcing*

Webster's Dictionary (1993 edition) defines "outsourcing" ..
*.....as in purchasing cheap foreign parts instead of manufacturing them at home.*

> *If the waning interest in scientific careers displayed by the young generation in the West has played an important role in globalization going in unpredicted directions, another, at the opposite end of the cultural spectrum, came with the forces of capitalism, industrial companies from developed countries in the West tapping into cheap labor in distant places on Earth where it was to be found. Today's massive outsourcing is no more than the predictable response to a new side of the supply/demand equation resulting from the needs of a demanding and growing population at home, the presence of low-wage human resources in other parts of the world - mostly Asia - and the new element that changed it all, an opening of borders and largely facilitated means of communications, of transportation - means that had not exactly been introduced with those objectives in mind (this is where it all started, but then went to other things, as we shall see).*

The implicit image of a developed world had in the 1950's been one where, other than for a few remaining relatively autonomous, countries would each have some industry or saleable products of their own, and international exchange would be in the form of reasonably finished goods crossing borders. By contrast, what has taken place is that private companies in the West have grown geographically, fragmenting their operations, distributing the parts in places on Earth that were most profitable to them. This began with unsophisticated manufacturing that is easily outsourced, then moved on to exporting research, management, the manufacturing of more sophisticated products.

Why outsourcing has as of late come to be much decried is not a question of principle, but a question of size. Protests did not surface until the number of exported jobs began to hurt large segments of the working population in the West. Many of those manufacturing jobs at home that were exported have been replaced with lower pay service jobs, decimating large portions of the middle class in the process. With a waning middle class, stores selling cheap merchandise (made elsewhere) have been on the increase, reaching national proportions in the US - with the New York Times publishing a front page article entitled *"Is Wal-Mart Good for America?"*[27]. What had started as a convenience ended up a necessity. Those who call this "good" only forget how one got there in the first place.

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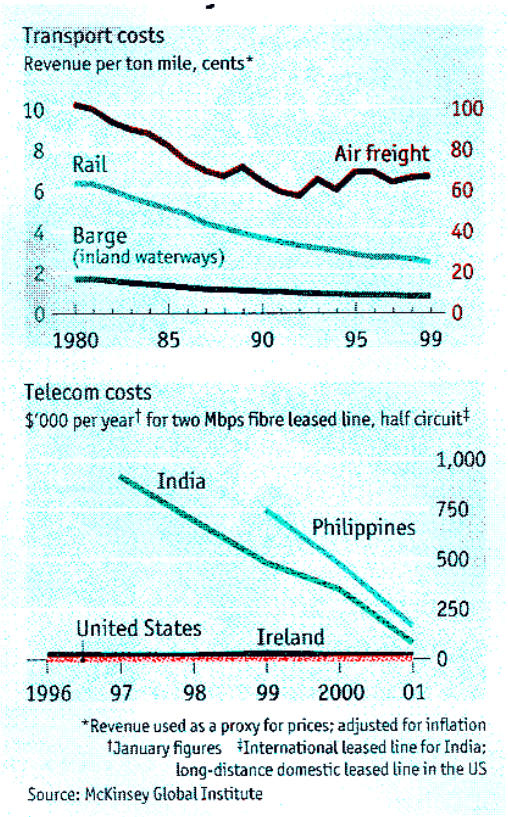
[27] *The New York Times* - December 7, 2003 (Wal-Mart is an American chain of stores specializing in selling "cheap" goods, mostly made in China, using a sales staff paid close to minimum wages)

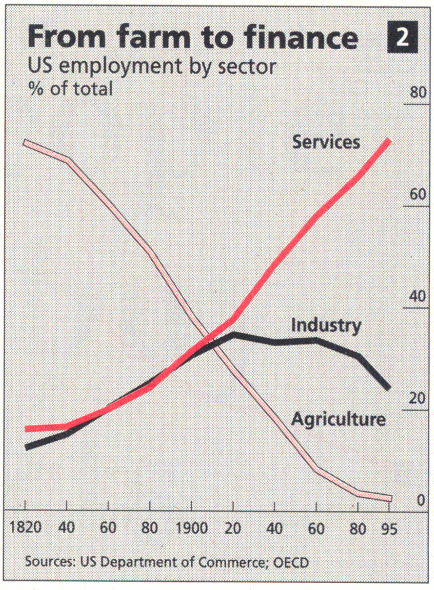



*One of the essential factors behind outsourcing: the decreasing cost of transportation and communications.*

*The Economist, Nov 13 2004*

Things got worse when it was no more just manufacturing but also intellectually more demanding, better paying jobs that went overseas, leaving both white and blue collar workers unemployed at home. This had been the case for some time with computer software development outsourced to places like India, Ireland and Israel (a late entry is Russia). Somewhat related is what is called "Business Process Outsourcing" going mostly to India, English competency having of course something to do with that[28]. And we were recently told of radiologists located in India interpreting on line X-ray pictures coming by way of the Internet from clinics located in the United States.

[28] according to an Indian web site selling this outsourcing service : " *Business Process Outsourcing (BPO)*" is the delegation of one or more IT-intensive business processes to an external provider that in turn owns, administers and manages the selected process based on defined and measurable performance criteria ".




*Employment in the manufacturing industry has been declining in the West since Word War II. Part of this is to be attributed to an increased mechanization of production, but also, in particular for the U.S . , to the outsourcing of labor intensive jobs to other parts of the world.*

Source the Economist, sept 28, 1996

figure 3

That the number of those employed in the US has not declined, is even increasing, something those in government like to brag about would seem to be in disagreement with the above. But those numbers do not say that well paid manufacturing jobs have been replaced by low paying service jobs. Consistent with this, many families that were doing well on one manufacturing salary have now to depend on two lower paid service jobs to survive.

And that official reports of employment shown to the public omit separating manufacturing from service jobs (a worker in an automobile manufacturing factory is significantly better for the economy that a salesperson in a department store) is revealing of the restricted horizon of those who publish those reports - or that of those higher up - members of the *economics* culture for whom those numbers are prepared (an omission hard to explain to those of the *science* culture.

Publishing employment figures broken down between manufacturing and service would be significantly more informative about what goes on.

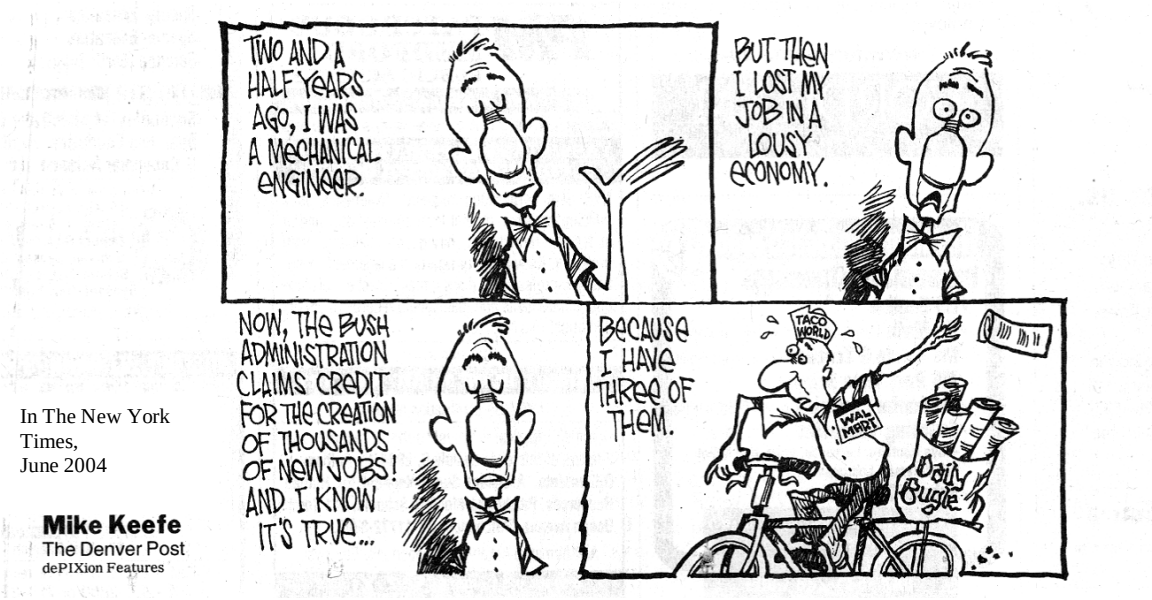



**Figure 4**

It was Adam Smith who, over two centuries ago noted that (these may not be the exact words) *"a man gets rich by employing many workers, a man gets poor by employing many servants"*[29]. This translates today into an evident correlation between the replacement of manufacturing with service jobs and balance of trade. When a manufacturing job is lost to outsourcing, the result is a net loss for the country, since the product being manufactured must now be bought from abroad if its final destination was the U.S., or it reduces export dollars income if it used to sold abroad (this includes computer software, a saleable commodity – just look at the gross revenue of Microsoft). In that respect, the trade deficit of the U.S. happens to be in correlation with numbers of manufacturing jobs lost in the same period of time (figure 7). Some three million of jobs were lost over the past three years or so (about half of them in computer-information technologies). Over the same period, the trade deficit has increased by about $200 billion a year. If we were, for the sake of the argument, assuming that jobs and trade are the only factors in presence, the above figures would indicate an exchange rate not far from $100,000.- of annual trade lost per outsourced job, in reasonable agreement with the numbers shown in figure 6.

*Today's US trade deficit of $500 billion a year translates roughly in 5 million (mostly middle class) jobs having left the country.*

[29] in A. Smith, *"The Wealth of nations"* , 1776

**Figure 5**

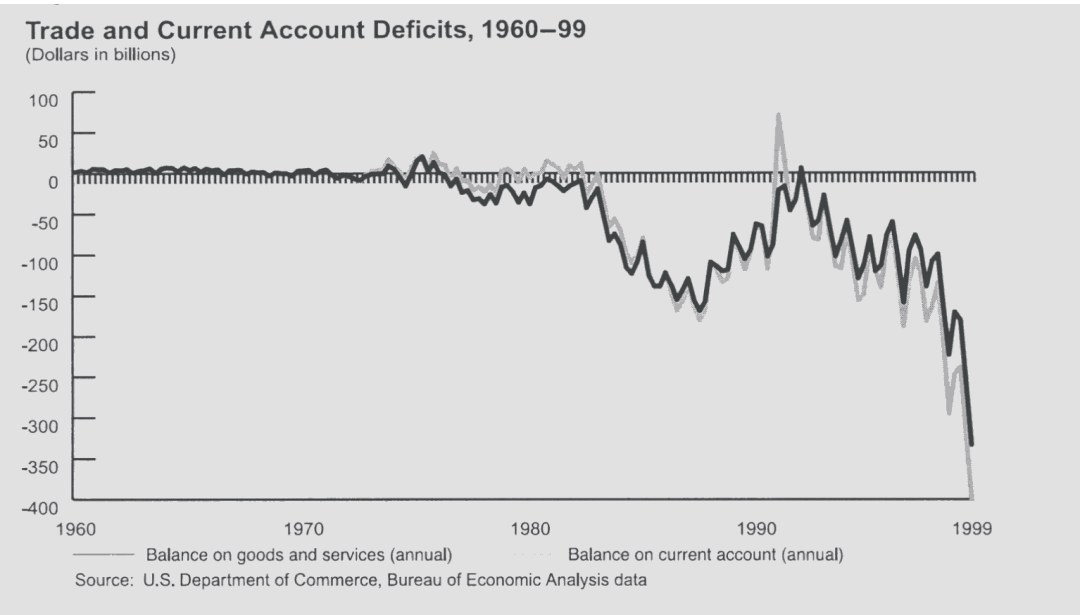



**Figure 6**

losses from the change in the trade balance with China between 1992 and 2000.

***Table A3: Estimated job loss from growing U.S. trade deficits with China, 1992-2000***
***(Millions of constant 2000 dollars)***

| | 1992 | 2000 | Change 92-00 | Jobs lost or gained |
|---|---|---|---|---|
| **Exports** | 8,183 | 21,685 | 13,502 | 121,365 |
| **Imports** | 28,378 | 103,518 | 75,140 | - 879,664 |
| **Trade balance** | -20,195 | -81,833 | -61,638 | -758,299 |

Data: U.S. Census Bureau for official U.S. trade data; adjusted by authors.
Factor content of trade (from Scott 2000): $1 billion exports = 8,890 jobs; $1 billion of imports = 11,707 jobs.

### *going away II : offshoring*

It was nice when one could buy cheaper goods made overseas, all else remaining the same. But all else did not remain the same. With increasing amounts of manufactured products being outsourced, Western companies have moved facilities, trained and encourage the training of workers and middle management, developed scientific and logistic infrastructures in places on Earth where human resources were available (the combined population of China and India is over three times that of North America and Europe). Those companies have become "multinationals" and the Western, mostly American identity to which they hold (also some European) has come to have often more to do with management and finance than with actual operations.

*Offshoring*[30] is a new word (it does not appear in the 1993 edition of Webster's Dictionary) that had to be created to describe this new situation : Western companies spreading their wings overseas, as opposed to creating indigenous, independent industries on other continents - the thing that was implicit in the 1940's and 50's, the original intent of globalization. The massive amount of outsourcing that is seen and highly decried today is the tip of that self-made iceberg, the symptom of a deeper change in the global industrial establishment. "Outsourcing America" , as it is negatively labeled in today's US press is no more than the *wake up call* of a problem that has been in the making for several decades with western private companies developing overseas industrial/research establishments, facilities equipped with all that is needed to successfully compete with those at home, in the West. And by contrast with what the public is led to believe (especially during presidential election campaigns), it would take the same decades to reverse the process – assuming, optimistically that one could re-interest those of the young generation to come back to science/engineering careers (which in itself is more than doubtful).

Important to note is that this success story of capitalism - which is what it amounts to - has been assisted by political geography. Given the lapses in accountability that come with their global distribution, multinational corporations are in a position to engage in practices that might well be unacceptable if they were conducted under the financial scrutiny of a single country, in full view of the general public at home[31].

---

[30] the French word "*delocalisation*" is more accurate

[31] along related lines, part of China's industrial success is to be attributed to the fact that the country is not ruled by a democratic government. Its intense development in the Eastern part of the country at the expense of letting inland populations of the country in extreme poverty is not something American companies working with China like their stockholders to be too much aware of.

## *the United States in the 2000's*

In spite of problems with outsourcing and of its dependence on foreign manpower and foreign brains, the US continue to play a central role on the fronts corresponding to the "two cultures", that of economics and that of science-knowledge (with Japan as a single country coming in second place).

Beginning with economics :

Today's global prosperity is a complex proposition, depending on countries all over the world finding buyers for their products, depending on a global circulation of money. This has, in the decades following World War II (not unrelated to the growth, during the war, of a large technology research and industrial production establishment in the US) come to be overwhelmingly a function of America's demand. If this demand were to drop significantly, the world would tumble into recession. It has been said that excessive reliance on America is one of the biggest problems facing the global economy today. As Laurence Summers, Treasury Secretary under president Clinton once put it, *"..the world economy is flying on one engine"*, also the title given to a recent survey of the situation in *The Economist*[32]

This is not a comfortable situation. For one thing, Americans have spent beyond their means for the past few decades, as shown by the increasing trade deficit and national debt[33], and, unless some drastic change takes place, this economic leadership shall not survive. But *The Economist* suggested (giving it the name of *"O'Neill Doctrine"* : Paul O'Neill was a former Treasury Secretary under Bush) that in the new world in which we live, trade deficit was not necessarily damaging !!

On the other hand, plausible scenarios have been arguably formulated that compare the fate of the US with the rise and fall of the Roman empire. One of them is found in Emmanuel Todd's book suggestively entitled *"After the Empire"*[34]. Other countries (in particular China) would take over. But when numbers are taken into account, it becomes evident that the global economic dependence on the US is not about to change soon : its GNP is several times the size of China's, and its manufacturing sector is bigger than the entire Chinese economy.

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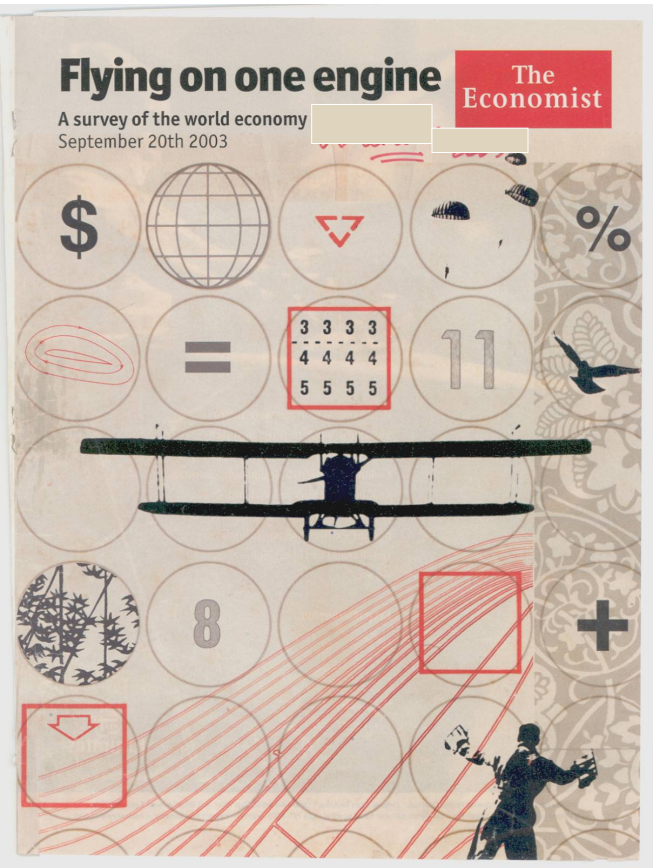
[32] *The Economist*, September 20, 2003

[33] This is about at the same time large numbers of foreign, mostly Asian students began appearing in American graduate schools.

[34] Emmanuel Todd "After the Empire", translated from the French "Après l'Empire"

**Figure10**




America can no longer propel the global economy. Unless other countries take over, argues Zanny Minton Beddoes, the economic outlook is grim and globalisation is at risk

The country, or more precisely that enterprise sailing under the American flag but that is geographically distributed around the world and staffed with large numbers of non-Americans, also in a somewhat convoluted way holds the leading place when it comes to knowledge and innovation. It is the first innovator in science and technology, the first in numbers of patents filed, in generating intellectual property, those things that have changed life on Earth in little more than a half century. Given the large foreign participation, those patents are of course not necessarily all filed in the US and many of the named inventors are not American born. Numbers of those patents are filed elsewhere by American companies having established research laboratories offshore, capitalizing on foreign brains. There is a long history behind this state of affairs. America is the country where the triode was invented (Lee de Forest - 1907 ), the country that saw the first electronic computer (ENIAC - 1946), the first transistor (Bell Labs in the late 1940's) , integrated circuits, the first computer chip (Texas - 1964), where Internet was developed (DARPA, the 1970's), where the Human Genome Project was initiated in 1990[35]. It is where Microsoft saw the light making the company's CEO Bill Gates the richest men on Earth, and where more leading developments in informatics, bioinformatics, the life sciences are still taking place in the 2000's.

How the country got to its present situation deserves some looking into. Capitalizing on the science-industry establishment that was a byproduct of the war effort, the US had in the subsequent decades become a bastion of science, technology, industry. It is not just its strategic and geographic position during the war that gave it an edge for leading in new developments, for having created research and education centers that were to later attract students and scholars from all over the world. Another advantage, and a non negligible at that (in particular when compared with Europe) is in the sheer size of the country combined with the use of a common language (English) and few impediments to mobility within its borders. The country is larger than Western Europe, it functions (or did function) with flexible employment and immigration regulations and a reasonably uniform social system. American and foreign scientists, engineers could come and go without much difficulty from one research and development center to another, from one research project to another, often for short bouts of a few years at a time - a combination of factors not present elsewhere [36].

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[35] Begun formally in 1990, the U.S. Human Genome Project was a 13-year effort coordinated by the US Department of Energy and the National Institutes of Health. The project originally was planned to last 15 years, but rapid technological advances (some accomplished by the French) accelerated the completion date to 2003.

[36] why the past tense is used in some of the above is that certain of those things are changing, in no small way and not for the better as a result of the American anti-terrorist measures - the Patriot Act instituted following the September 11, 2001 attack on the World Trade Center

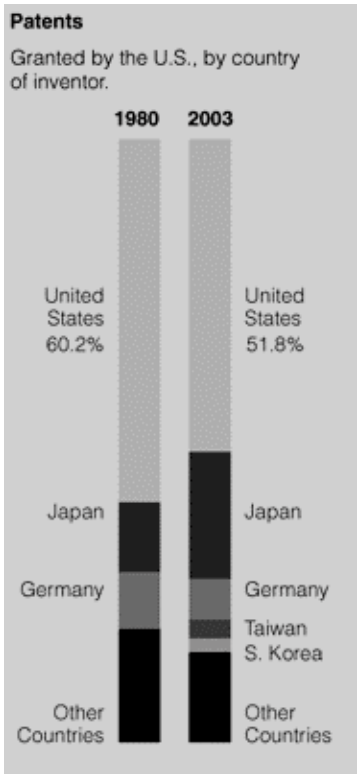



Figure 11

*The article where this appears is entitled* "U.S. is losing Its Dominance in the Sciences". *Although on the decline, the number of patents filed by U.S. residing inventors is outranking those from countries of the rest of the world. Many of the "inventors" residing in the U.S. may well not be American born.*

*(Note the importance of Japan, at least up to recently the second largest economy in the world - having evidently a significant scientific research and development activity).*

*(The New York Times May 04, 04)*

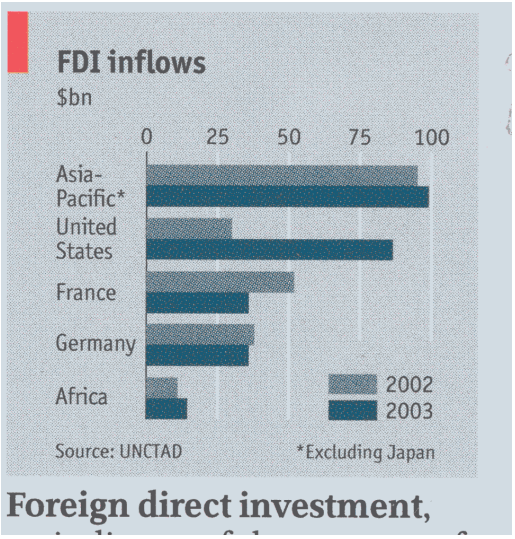



Figure 12

*The United States have, as a single country been the largest magnet for Foreign Direct Investment , capital that contributes to fueling scientific research and industrial development ( countries of the Pacific Basin are catching up, in particular China with $53 billion of investment in 2004. ) .*

*The Economist*

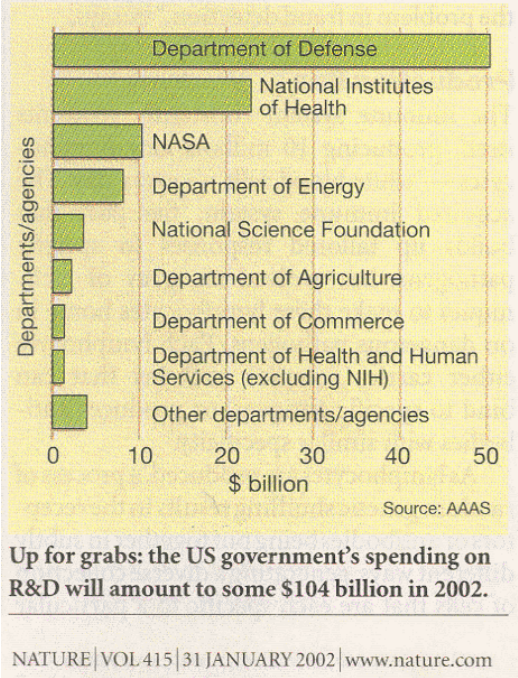
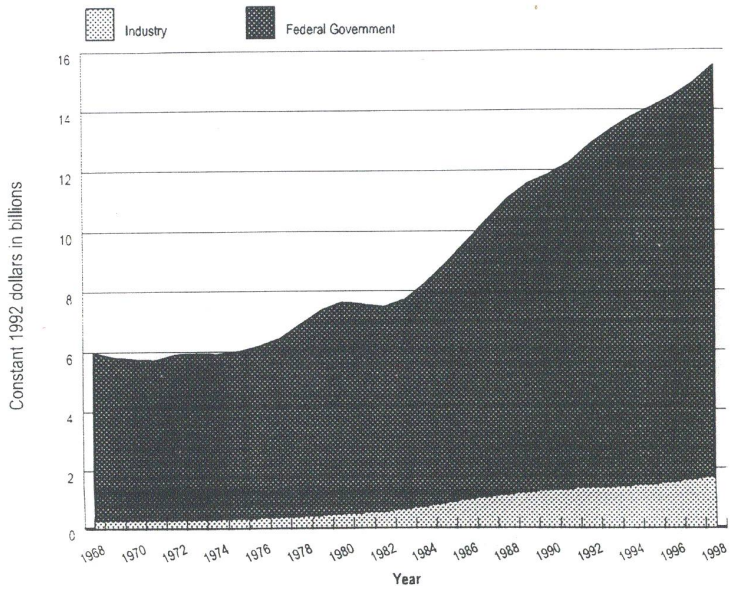



Figure 13
*US Research and Development spending by the US government – - year 2002*




*Source:* Association of American Universities, National Science Foundation.

20 Working Together. Creating Knowledge

*Federal and Industrial R and D funding of Universities in the U.S. The federal part represents between 10 and 20 percent of the total federal financing of research and development.*

Figure 14

Local conditions have also allowed for the rise of sizeable, geographically concentrated communities devoted to science and high technology in the US. The very size of those communities is a plus, providing a favorable climate not only for research but also stimulation, an important element of creativity. A good reading, in that respect, is an article by Locke entitled, *"No Talking in the Corridors of Science*[37]*"* where the point is made of the importance of informal, face to face communication is scientific accomplishments (citing for instance the *cocktail napkin* as a device often contributing to the discovery of new ideas).

Large research communities in the US also create environments that tend to attract scientists from elsewhere, from abroad. Examples are the famed Silicon Valley in California, the Boston area and its no less famous surrounding Route 128 in the North East both by no coincidence, located near Ivy League universities where significant governmentally funded research has been going on for decades (Stanford/Berkeley for the former, MIT/Harvard for the latter), and whose population has become very cosmopolitan.

Then there are large research - governmentally funded Institutes (the National Institutes of Health's government funding for research and development is second only to the Defense Department), Administrations (NASA, DARPA,....), Laboratories (Los Alamos, Livermore, Oak Ridge – all three by the way having originated with the development of nuclear weapons, though much of their present range of activities goes well into more pacific domains). And there is the recent part private, part public biotechnology/life sciences enterprise with investments in the billions of dollars a year and participants that must count in the millions. An illustration is that of the Society for Neuroscience, a (mostly) American professional society that grew from 500 members when it was formed in 1970 to some 34,000 today. Its Annual Meetings, held in large US cities, attract on the order 30,000 attendees[38]. Another illustration is that of IBM having developed in Yorktown Heights a supercomputer named *Blue Gene* at a cost of $100 million, for an expected market of $9.5 billions - to serve one particular aspect of biotechnology, the simulation of protein folding. As an interesting byline, it was noted that the computing load associated with simulating the folding of a single protein *".....makes the simulation of a nuclear explosion or the formation of a galaxy look like a picnic*[39]*"*.

---

[37] Locke *"No Talking in the Corridors of Science"* - the American Scientist

[38] see http://www.sfn.org

[39] *The Economist Technology Quarterly*, December 2000.

Also characteristic of the US is the presence of what is referred to as "big science". Quoting from a recent article in SIAM News :

*....."An evolution has been seen in many branches of experimental physics where individual investigators and small teams have been succeeded in many cases by large groups centered around billion dollars facilities such as accelerators, lasers, telescopes, and tokamaks engaging not only physicists but also statisticians, engineers, support technicians and others …*

*....The United States is well positioned to induce [the same] throughout the sciences and engineering, from plasma physics to biotechnology[40]".*

The significant governmental funding of research and development that was initiated for strategic reasons after World War II is still going on, keeping the country well ahead on the world scene. Interestingly, the science/academy establishment has become a force of its own, lobbying for these funds (for their own good, though not forgetting to mention "national interest" as their motive – a not so unusual combination in which both parties are to benefit). There are enough scientists in the country to make this possible – something not easy to come by in smaller countries, including those of Europe, or even Europe as a whole where there is a lack of cohesion between the Union's countries.

I like to mention in that respect the HPCC (High Performance Computing and Communication) a project, that has been funded by Washington since the early 1990's to the tune (in 2004) of over one billion dollars a year. Its continuation is justified year to year by substantial reports to the US Congress prepared by ad hoc committees formed of academic and industrial scientists. The following is an example of what those reports contain.

[40] D. Keyes "Building a Science-Bases case for Large-scale Simulation" in SIAM News - September 2003

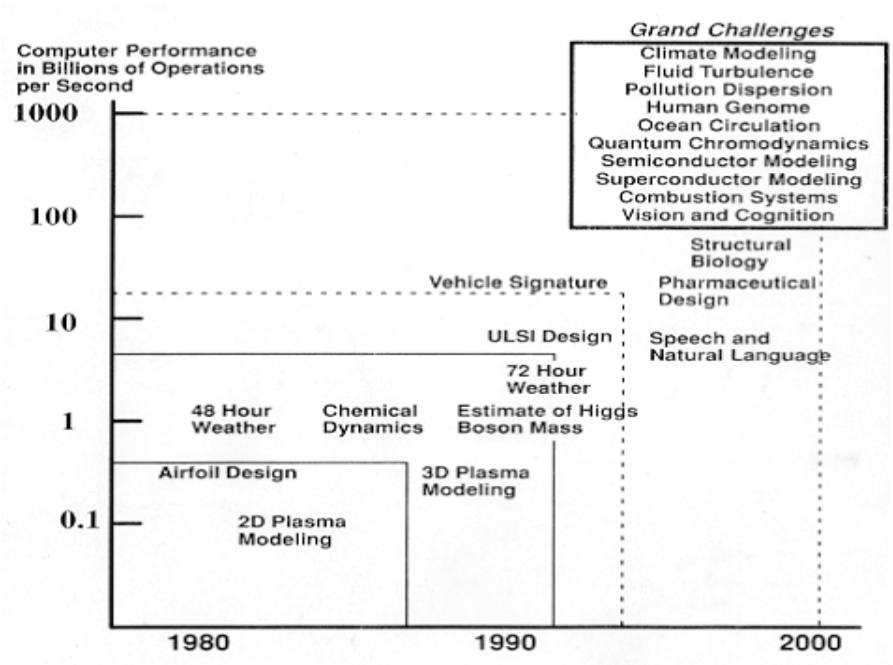



**Figure 15**
*from "Grand Challenges : High Performance Computing and Communications", a report to the US Congress presented to support funding of large computers and communications development as part of the President Fiscal Year 1992 Budget*

Quoting from the accompanying text[41] :

*"High performance computing has become a vital enabling force in the conduct of science and engineering research over the past three decades, Computational science and engineering has joined, and in some areas displaced. the traditional methods of theory and experiment, For example. in the design of commercial aircraft, many engineering issues are resolved through computer simulation rather than through costly wind tunnel experiments "*

and ...

*"Although the US is the world leader in most of the critical aspects of computing technology, this lead is being challenged". .....*

which illustrates the degree to which national superiority in the science and engineering are used as the motivation to have the government invest significant finances in developing ever more powerful computers and communications between computers, something that has become an integral part of the scene.

[41] HPCC Bromley 1991

The results are indeed spectacular. But the story would not be complete if we were not reminded – once more - of the fact that today's participants in these American accomplishments are increasingly foreign born, having started their education abroad, and that some of these projects are conducted outside of the American territory altogether. And it must have been predictable that using funds intended to increase the scientific potential of the country to educate large numbers of students coming from abroad would lead to some kind of trouble (in the long run, but this is something governments in power do not seem to worry much about). Other than for contributing to an acceleration of offshoring, it has led to a dangerous strategic and economic dependence of the country on foreign talent, a question that became critical when a *de facto* partial closing of American borders to scholars and students was imposed as part of the post September 11, 2001 anti-terrorism measures.

If the question had been addressed at the time - may be 25 years ago - there might have been less of the "*outsourcing of America*" decried nightly in today's US media. Why this significant increase in the population of foreign students and what it was revealing on a broader scale did not come to the public's attention when it started several decades ago is to be attributed to the fact that the question resides somewhere between the two cultures. It is not what economists and the executive branch of governments keep much abreast of. And it is not what scholars and academics in the hard sciences see a problem with. Their belief is that the exchange of knowledge, which applies to educating students (which has no short term visible impact anyway) is not to be questioned, that science must not know about borders. Given the multiethnic nature of the American society, it might even have been perceived as politically incorrect to raise any objection.

## *giving knowledge away*

What is happening is that much of the knowledge, the know how that had for a couple of centuries been the source of strength of the North Atlantic, of the US and Europe is being exported, given away. Other than for the education of foreign students and academic exchanges, a significant part of this takes place, and has for decades, almost surreptitiously in fact under the cover of private companies, mostly American expanding their operations overseas, becoming multinationals.

The 2003 Annual Report of the leading computer chip manufacturer *Intel says* that *"more than 75% of our wafer manufacturing was conducted within the U.S."* (that part is capital intensive : *"fabs"*, those facilities where silicon wafers are produced cost in excess of $1 billion each - using relatively few workers). But then, significantly ... *"We perform the majority of our components assembly and test facilities in Malaysia, the Philippines, Costa Rica and China"* and *".. plan to begin construction of an additional assembly and test facility in Chengdu, China ...."* (these are parts of their operation whose need in personnel is higher). It was recently announced that *Intel* is conducting part of its research and development operations in Russia, and that it was its intention to increase it. To be noted also is that their sales to the Asia/Pacific market have increased from about 90 percent to close to 150 percent of sales to the American market between 2001 and 2003 (see table next page).

Away from high-tech - *General Motors* announced plans to invest $3 billion for the development of car manufacturing plants in China - mostly for the Chinese market and adding to the $2 billion already there[42]. And likewise for many others – including the European car manufacturer *Volkswagen*. As a sign of rising lifestyles, the news agency Reuters reported that *General Motors* would begin in 2005 production of their *Cadillac* car in China, in part for the Chinese market[43]. This is even more informative when one finds out that *General Motors* announced a few months later that it would in the near future reduce its workforce in Europe by 12000 jobs , most of these in Germany[44], and by 8000 jobs in the US (announced in January 2005).

[42] *Detroit Free Press* editorial, June 8, 2004
[43] www.theautochannel.com/news/2004/08/15/209308.html
[44] CBS/ Associated Press/BBC News – October 14, 2004

At December 27, 2003, we owned the major facilities described below:

| No. of Bldgs. | Location | Total Sq. Ft. | Use |
|---|---|---|---|
| 121 | United States | 27,092,000 | Executive and administrative offices, wafer fabrication, research and development, sales and marketing, computer and service functions, boards and systems manufacturing, and warehousing. |
| 9 | Ireland | 3,443,000 | Wafer fabrication, warehousing and administrative offices. |
| 12 | Malaysia(A) | 2,223,000 | Components assembly and testing, boards and systems manufacturing, research and development, warehousing and administrative offices. |
| 16 | Israel(B) | 1,978,000 | Wafer fabrication, research and development, warehousing and administrative offices. |
| 5 | Philippines(C) | 1,518,000 | Components assembly and testing, warehousing and administrative offices. |
| 4 | Costa Rica | 863,000 | Components assembly and testing, warehousing and administrative offices. |
| 4 | People's Republic of China(D) | 685,000 | Components assembly and testing, research and development, and administrative offices. |
| 1 | India | 271,000 | Sales and marketing, research and development, and administrative offices. |
| 1 | United Kingdom | 175,000 | Sales and marketing and administrative offices. |
| 3 | Japan | 158,000 | Sales and marketing and administrative offices. |
| 1 | Germany | 80,000 | Sales and marketing and administrative offices. |

The following table sets forth information on our geographic regions for the periods indicated:

| (Dollars in Millions) | 2003 Revenue | 2003 % of Total | 2002 Revenue | 2002 % of Total | 2001 Revenue | 2001 % of Total |
|---|---|---|---|---|---|---|
| Americas | $ 8,403 | 28% | $ 8,648 | 32% | $ 9,382 | 35% |
| Asia-Pacific | 12,161 | 40% | 10,073 | 38% | 8,308 | 31% |
| Europe | 6,868 | 23% | 6,139 | 23% | 6,500 | 25% |
| Japan | 2,709 | 9% | 1,904 | 7% | 2,349 | 9% |
| **Total** | **$30,141** | **100%** | **$26,764** | **100%** | **$26,539** | **100%** |

*(from Intel 2003 Annual Report)*

*Note that sales to the Asia –Pacific market have increased from about 90 percent to close to 150 percent of the sales to the American market between 2001 and 2003*

Then there is the interesting case of IBM. *The Associated Press* reported in the Fall 2004 that

> *".... IBM documents said .. about 4,700 programming jobs could be shifted overseas to save costs, a growing high tech industry known as "offshoring"….*

and then, significantly, .....

> *IBM spokesman James Sciales …. noted that most of IBM's workforce, which now totals 315,000, has been overseas for years.…..Often, the American workers being replaced are called upon to train their overseas replacements*[45].

That *"most of IBM's workforce has been overseas for years"* is something the public - including those who invest their money in IBM stock has to a large extent been unaware of, something, in spite of its strategic importance, even the executive branches of governments seem to pay little attention to. The next step, predictable when one takes all factors into account (something governments do not do enough) came when it was announced in December 2004 that IBM was selling its prestigious Personal Computers division ("*Thinkpad*" is often thought as the best laptop computer) to *Lonovo*, a Chinese company, that *Lenovo* would be allowed to continue using the IBM logo for the next five years. From the *New York Times*[46] :

*"While Lenovo will have its headquarters in New York, the hub of the I.B.M. Personal Computers business is in Raleigh, N.C., where its design and development operations are based. I.B.M. employs about 10,000 people worldwide in its PC business, although fewer than a quarter of those workers are in the United States. In fact, 40 percent already work in China."*

This was no more than officializing an existing situation : few, if any P.C.'s are manufactured in the US any more (the IBM Thinkpad I am using to type this paper says "Made in Korea"). The degree to which this is unpublicized, misrepresented by the American media was illustrated by a commentary made after this announcement had been made by a well placed analyst appearing on the "Lou Dobbs" nightly CNN program, saying that:

*..... "They [China] sell us trinkets and then buy from us the crown jewels of our industry"* showing an ignorance of the fact that most of the development and manufacturing content of those *" crown jewels of the American industry"* have for years, perhaps decades left the US territory for Asia.

But the image of China as "*trinket makers"* persists. And the "official" message, that coming from government circles and heard by the public does not say otherwise.

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[45] *The Associated Press*, reported by CNN.com December 15, 2003
[46] *The New York Times* - Dec 8, 2004

## *publishing, education*

Unforeseen consequences of the rapid increase of funding in the sciences in the US in the post World War II years are found in unexpected places.

It may be good to be reminded of the fact that, at least before the 20th century, "research" used to be conducted only by members of aristocracy, something I found called "a gentlemen's hobby" by Charles Babbage biographers [47]. Some research was conducted by some university professors, but "publishing" was not a must, was not common practice, except for a very few. How all of this changed came with the inception of funding not much more than half a century ago. With increasing numbers of students engaged in research toward obtaining their Ph.D. degree and publishing papers (publishing possibly to show their sponsors what progress was being made), university faculty whose most important responsibility had in the past been that of being good, motivating teachers became to also supervise those graduate students. By way of consequence, they too began to do research and publish papers of their own - at the expense of attention given to teaching. This led in a convoluted way to that system - in the US at first , later adopted to different degrees by other countries - that requires educators to do research on their own and publish papers to prove their competence as teachers, the "publish or perish" syndrome. This is in contradiction with the original intent. With too much attention given to research, the quality of teaching - in particular to undergraduate students in the sciences has been seriously affected[48]. So, paradoxically, governmental funding that was instituted to increase the scientific potential of the country ended up contributing to young students, those in undergraduate classes - mostly Americans - losing interest in the sciences, perhaps a good example of what Forrester meant by his *"Counterintuitive Behavior of Social Systems"*[49].

In the end the country has unintentionally come to have graduate and undergraduate classes in the natural sciences and engineering filled with very different populations. Undergraduates are predominantly native born and their competence in mathematics, physics, the sciences, is limited. Graduate classes consist on the other hand of mostly foreign students, many from Asia having completed their undergraduate studies at home, generally coming with a much better preparation in mathematics and science than the locals. In a deposition on March 23, 2003 before the Committee on Science of the U.S. House of Representatives, Shirley Tighman, President of Princeton University reported that approximately 43 percent of the graduate student population at Princeton were foreign (the number would be higher if it were

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48 see M. Kline *"Why the Professor can't teach"* 1977 – St. Martin's press.

49 Jay W. Forrester *"Counterintuitive Behavior of Social Systems"* a paper based on testimony for the Subcommittee on Urban Growth of the Committee on Banking and Currency, US House of Representatives, October 1970. Appears in *Toward global equilibrium* D.L. Meadows and D.H. Meadows, Wright Allen Press , 1973

restricted to students in the natural sciences and engineering) - against only about 7 percent of the undergraduates[50] And most significantly:

> ..... " *Non-U.S. nationals .. thanks to science, math, and technical preparation superior to that of many Americans, ..... increasingly fill American graduate studies seats and job slots in these areas"* [51].

There are also deeper consequences. The disappearance of nearby factories and of a visible middle class contributes to depriving the young of role models that would motivate them toward careers related to technology, to industry, adding to their general disinterest in science and engineering. Somewhat related comments by Vivek Paul, an Indian entrepreneur specializing in outsourcing said ..

> ... *massive outsourcing ..... raise[s] for America the long term worry of "the disruption of the apprentice path". Even if the work done [abroad] is not at the most advanced and sophisticated technical level, it is filling what used to be part of the professional experience that has helped to create America's legions of great innovators. Just as once unassailable American corporate R and D departments have seen their sway weakened , will it be long before America itself loses its near monopoly of global innovation ? "*[52]

That much of the above is taking place creating of a wider problem. Revealing in that respect is the fact that high school students ratings in mathematics and the natural sciences place Singapore, Japan, South Korea, China near the top of the list, with the United States ending up more or less in fifteenth place, behind most of the European nations and the Russian Federation.

[50] These numbers may be in the process of changing with a significant reduction in the inflow of foreign students resulting form the recently instituted anti-terrorist measures : the Patriot Act.
[51] published in *Academe*, the Bulletin of the AAUP, sept/oct 2003-
[52] "Innovative India' , *The Economist,* April 3d, 2004


1999 (http://nces.ed.gov/timss/) Figure 15

| Mathematics | | Science | |
|---|---|---|---|
| **Nation** | **Average** | **Nation** | **Average** |
| Singapore | 604 | Chinese Taipei | 569 |
| Korea, Republic of | 587 | Singapore | 568 |
| Chinese Taipei | 585 | Hungary | 552 |
| Hong Kong SAR | 582 | Japan | 550 |
| Japan | 579 | Korea, Republic of | 549 |
| Belgium-Flemish | 558 | Netherlands | 545 |
| Netherlands | 540 | Australia | 540 |
| Slovak Republic | 534 | Czech Republic | 539 |
| Hungary | 532 | England | 538 |
| Canada | 531 | Finland | 535 |
| Slovenia | 530 | Slovak Republic | 535 |
| Russian Federation | 526 | Belgium-Flemish | 535 |
| Australia | 525 | Slovenia | 533 |
| Finland | 520 | Canada | 533 |
| Czech Republic | 520 | Hong Kong SAR | 530 |
| Malaysia | 519 | Russian Federation | 529 |
| Bulgaria | 511 | Bulgaria | 518 |
| Latvia-LSS | 505 | **United States** | **515** |
| **United States** | **502** | New Zealand | 510 |
| England | 496 | Latvia-LSS | 503 |
| New Zealand | 491 | Italy | 493 |
| Lithuania | 482 | Malaysia | 492 |

## *the 9/11 follow up*

The so called "Patriot Act " shall go down in history as a memorable example of damaging consequences of a government ignoring important information coming from the culture of science and engineering in major decision making, shooting oneself in the foot. The Patriot Act was signed by the US Congress in October 2001 in the wake of the September 11 attack on the World Trade Center established, among other anti terrorism measures ... *"to deter and punish terrorist acts in the United States and around the world, to enhance law enforcement investigatory tools, and for other purposes"* - making it difficult for most foreigners to obtain visas to enter the U.S.. But no difference was made for students, scientists and scholars, ignoring their well established importance to the American science establishment.

Measurable consequences in the short run have been seen in a major decline in the number of students applying to American universities. The test of English as a Foreign language (TOEFL – taken by all foreign students that apply to an American university) is losing its magnetism in China, with a sharp decline in the number of people taking the test nationally. In Beijing, TOEFL participants totaled 10,000 in 2003, a sharp decline from more than 30,000 in previous years. The number of TOEFL examinees stood at 100,000 in peak years, it was reported[53]. A statement issued on December 13, 2002 by Bruce Alberts, President of the National Academy of Science, William A. Wulf, president of the National Academy of Engineering and Harvey Fineberg, president of the Institute of Medicine contains the following

*…..…efforts by our government to constrain the flow of international visitors in the name of national security are having serious unintended consequences for American science, engineering, medicine. The evidence… reveals that ongoing research collaborations have been hampered; that outstanding young scientists, engineers and health researchers have been prevented from or delayed in entering this country; that important international conferences will be moved out of the United States in the future if the situation is not corrected. Prompt action is needed*[54]

The tone of this statement (coming from Presidents of American Academies) is as if what it said was "news" to members of government, members of Congress forwhich it was intended. This may well have been be the case for many of them.

[53] from the Beijing journal People's Daily - Nov 18, 2003 -- http://englishpeopledaily.com.cn
[54] in the September-October 2003 issue of *"Academe'"* (the journal of AAUP, the American Association of University Professors )

Facing a declining influx of foreign students and scholars on which they have depended for decades, U.S. companies have been encouraged to increase offshoring, moving to mostly Asia more of their operations that require skilled workers and scientists, whence weakening even more the knowledge base that had been the backbone of much of the global power of the US[55].

This has been illustrated by periodic press reports, among others by Microsoft, Intel and IBM, announcing increases in the number of employees in overseas research facilities (including Russia).

[55] restricting civil liberties in the US because of an outside threat is of course somewhat reminiscent of the 1950's

## *Europe in the 2000's*

Much of Europe's manufacturing industry had been destroyed during the war and had been reconstructed, in part with the aid of the Marshall plan. But contrary to a belief I often perceive in the US, continental Europe still had a significant presence in the sciences at the end of World War II. It may well be that few research laboratories were functioning - but most of the scientific knowledge had resided with university faculty, with professors whose primary obligation was to educate. And not much of that had been affected by the war. In fact, most universities (in continental, occupied Europe) had continued to function during the war years.

But when it comes to developing the kind of large scale industrialization we see today, there are fundamental aspects in which Europe is very different from the US. First and foremost , Europe's population is not (and is not about to become soon) an integrated entity. It consists of a mosaic of communities of men and women with different cultures, different languages, a different political past. Each is eager to preserve its age old individuality, its cultural heritage, a major point that underlies the difficulties encountered on the way to unification. The importance of this is generally not well perceived, but then this must be the only experience in modern times of attempting to create a single political, economic, industrial, even intellectual community by pulling together countries that have been politically, culturally, linguistically as separate as those found in Europe. How this will work out is still in question, but it will undoubtedly be different from the vision of an integrated community in the image of the US - that which was conceived in the 1950's .

Significantly, of workers, students, scientists who are now free to cross borders, only 1.6 % of them live permanently in a EU country other than their own. This was reported in a recent 16 pages survey of Europe given by *The Economist*, expressing the belief the cultural, administrative, human fragmentation of the continent was not about to disappear, ending significantly with the words *"vive la difference"*[56].

Language differences are not just a question of communication. There are other, less evident consequences : public opinion is to a large extent formed by the media, and in a multilingual Europe the media is inevitably divided, compartmentalized in linguistic islands, each spreading opinions attached to local interests. More than fifty percent of the population in the European Union does not undertand a language other that their own. By contrast with the U.S where the public's sense of belonging to a single community is to a large extend shaped by a same, English speaking media, this sense of belonging to a single community is unachievable in Europe.

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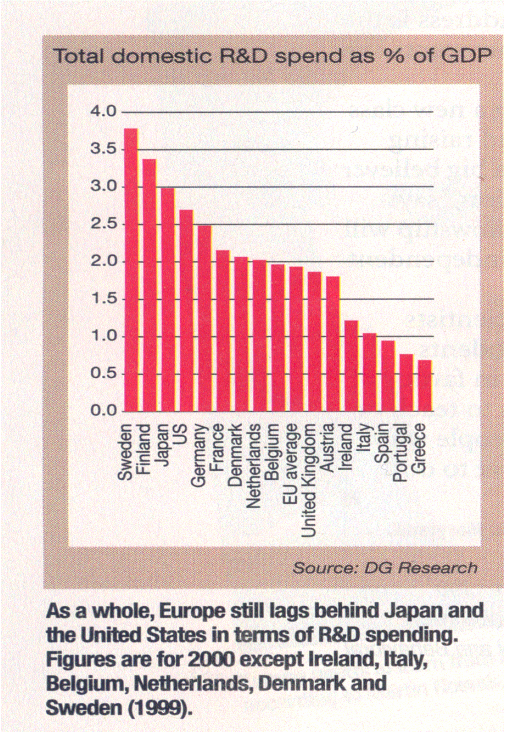
56 *"Outgrowing the Union"*. The Economist, September 25th , 2004

The European Union had eleven official languages before May 2004, a number that is now up to twenty two. Individual countries are not about to abandon theirs, no more than many of the other cultural traits that are different from one country to another. Of the budget and administrative personnel of the European Union, thirty percent was used to ensure translation of speeches and documents in those operative languages. I was recently while in Brussels listening to a radio program featuring an informal discussion between intellectuals and journalists (a kind of informal dialog more common on European airwaves than in the US, by the way). The subject was that of the increased number of official languages going from 11 to 22 in the wake of the enlargement the European Union from 15 to 25 countries on May 1, 2004. Then came the inevitable statement that it would be nice to adopt a single European language : those mentioned were *Esperanto* and *Latin* ! No one (in spite of the reality of the thing) mentioned *English.* That English is used in business for most international operations within the Community, that it has been for decades the *lingua franca* in the sciences was not even mentioned (and they were not joking). But then, there has been a tradition of resisting the pervasive infiltration of English in day to day life, in particular in France where doing so was at one time officially equated to, punishable as forgery.




**As a whole, Europe still lags behind Japan and the United States in terms of R&D spending. Figures are for 2000 except Ireland, Italy, Belgium, Netherlands, Denmark and Sweden (1999).**

**Figure 17**

*R and D spending in Europe is identified country by country, and shall remain so for the foreseeable future*

Governmental funding of research is limited and researchers are at a notorious disadvantage when compared to those in the US. Individual countries still insist on

running their own research and development program. It was Philippe Busquin, the Commissioner for Research and a scientist by training who in 2000 referred to Europe's poor performance in science productivity when compared with North America and Japan, due to

> *…….a fragmentation of resources and infrastructure, a lack of intergovernmental coordination and obstacles to the mobility of researchers, the downside of the cultural and linguistic diversity across the EU 15 member states".*
>
> .... a situation to which correction should be sought with the establishment of a European Research Area (ERA) whose aims would be
>
> *……to create the desired cohesion. Its goals include the harmonization of patent law, support for large scale infrastructure projects and existing centers of excellence*[57].

He also announced in 2004, the formation of a *European Network of Mobility Centers* designed to make it easier for scientists and their families to move around Europe[58]. But when implemented, this will do little to get over obstacles brought about by the cultural, linguistic, nationalistic divisions with which Europe shall remain saddled for a long time to come. Higher education is still uneven across the European continent. The Bologna reform of University education is under way, it may help in mobility of those who have a diploma, but evidence shows that uniformization of academic entities that may have centuries of traditions is not an easy process.

--*--

[57] *"Science sans frontières"* in the Economist, 25 October 2001

[58] in *The Chronicle of Higher Education* September 3, 2004 "Europe Strives to keep its Scientists at home".

***competing against whom ?***

After world war II, even before the 1960's when J.J. Servan Schreiber published his "*American Challenge*", Europe has – often not without resentment- used the US as the example of success to shoot for. And with Microsoft software and Intel computer chips present in many households, the belief is still to a large extent prevalent (much of the electronics sold in Europe and made in Asia or Eastern Europe still bears the logo of American companies). But what Europe tries to emulate is only an image, it tries to compete with a non existing "greatest scientific power on Earth" that it implicitly ssumes is populated with native Americans, competing in particular by trying to educate more European scientists. It misses the point that the American scientific/industrial power depends today (and has for the past few decades) on brains coming from elsewhere in the world. What the US provide are institutions and an environment where governmental as well as privately funded research is taking place, attracting foreign students, scholars, scientists, creating a first class multinational scientific establishment. And a significant part of what is attributed to the American establishment, research, innovation, development is conducted outside of the US by multinational corporations anyway. What is not generally realized in Europe is that the native American contribution is more in management, organization, finance, illustrated by the fact that an important direction chosen by young, ambitious Americans for their education is in business, finance.

Europe educating first class students in the sciences inevitably results in having numbers of those newly minted scientists (to which the familiar expression *"all dressed up and no place to go"* may well apply) emigrate to the US .

I may quote in that respect from a Belgian Ph.D. from my *Alma Mater* the Brussels Free University, having spent the past year as a post doc researchers in *plant biology* at the Colorado State University writing back to the committee of Alumni (to which I belong) that had partially funded him :

*" The American scientific activity rests predominantly on foreign researchers who represent a major contribution to the university community. In the larger market of scientific research at the world scale, project directors prefer recruiting European candidates that are judged better qualified . Europe is paying a high price..."*

The short of it is that European scientists are still educated for a world that exists no more, one where their European scientific education would be put to good use in Europe. They (in particular engineers) would be better off if part of their education was concerned with international economics, law, management (I was told that this begins to be done by some Canadian universities).

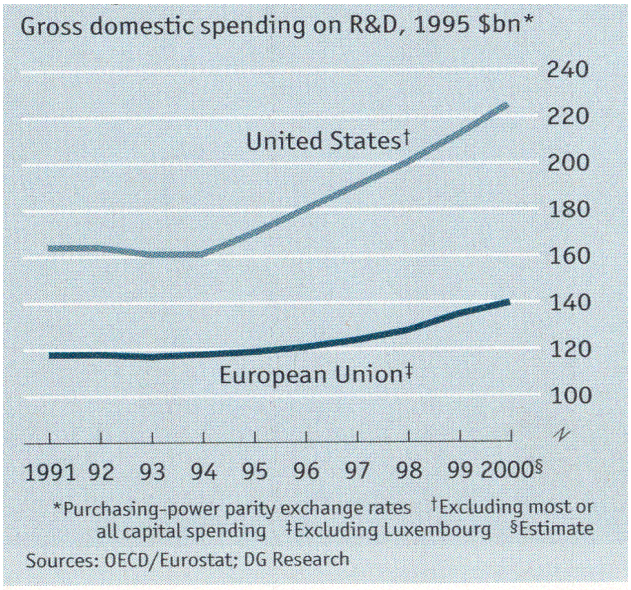
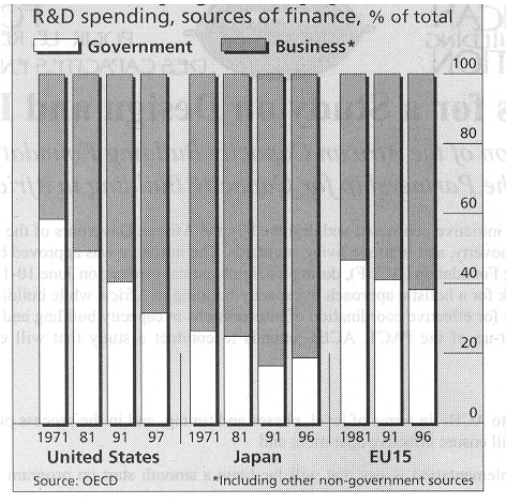
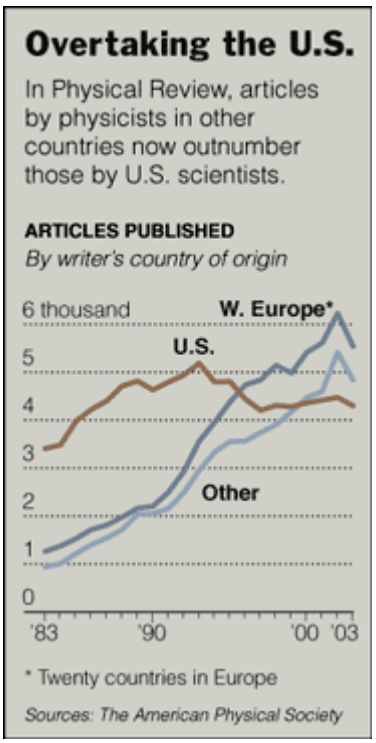



**Figure 18**

*Funding of research and development in Europe is significantly lagging that in the US*

**Figure 19**






The New York Times ,May 2004

*What is interesting in this chart is that it shows the decreased participation to publication (in Physics) of authors whose country of origin is the US, something consistent with the low performance in math and science of American high school students shown in a preceding figure .*

## *the positive side*

As the saying goes, every cloud has a silver lining. A difference of Europe with the US, is in a greater stability, a better preservation of the middle class in the European society While the disappearance of middle class society is noticeable in the US, this is much less the case in Europe.

An explanation, I believe, is in the fact that the same labor laws that were instituted in Europe over a century ago to protect the employment and compensation of workers against the excesses of a growing capitalism have - together with linguistic, cultural differences I mentioned and that have been responsible for the difficulties of industrial growth on the one hand (an equivalent of Sillicon Valley in Europe with participants coming from all over is hardly conceivable) seem to have also resulted in the fact that outsourcing (to Asia) has been less of a problem. There is a much less visible loss of middle class employment in Europe (I mean the "old" Europe : France, Germany, Great Britain, Belgium, ...)

This is an interesting turn of events : while more flexibility in employment regulation and less resistance to travel have been a significant factor in allowing the US to experience a fast industrial , scientific success in the second half of the 20th century, the same lack of restraints have arguably been responsible for the ease with which American firms have been able to lay off workers, exporting their jobs to lower wage parts of the world. I do not have the numbers, but Europe must have lost much less than the 5 million or so jobs lost to outsourcing by the US.

This may be changing with the enlargement of the Union, with the integration of ex-communist block countries where personal income is well below that in the "old" Western Europe, and toward which outsourcing is burgeoning, something I shall talk about next. But it will be a slow process.

## *Eastern Europe, Russia*

Significant economic changes are coming with Eastern European ex-communist countries having recently (as of May 1, 2004) joined the Union. There is for instance the case of Poland and the Czech republic (GNP per head $5,720 and $9,250) finding themselves, since May 2004 incorporated in the Community with rich countries like France and Germany (GNP per head $31,640 and $30,810). The Czech organized in the summer 2004 a trade fair in Germany, offering the manufacturing of automobile components in their country at much better prices. Not to be forgotten : Czechoslovakia was in the first half of the 20th century one of the technologically advanced countries in Europe. Ironically, it was reported by the media that Chancellor Schroeder of Germany, one of those officially charged with constructing a unified Europe went on record to say that those German companies that would "denationalize" part of their operation were "unpatriotic".


**Figure 20**

The problem is comparable with that which that faced over a decade ago with the reunification of Germany. France, Germany and Britain begin to feel the heat brought about by the new situation. There have been cases of workers accepting increased work time (from 35 to 36 hours per week at *Bosch* – France, from 35 to 40 hours at *Siemens* - Germany, with no increased compensation after having been given the choice between that or having their job being outsourced to Eastern parts of the newly enlarged European Union - something remarkable for France where unions will go on strike at the drop of a hat : workers simply bypassed them to keep their jobs. And workers at *Volkswagen* have been warned that an expected salary increase at year end might not materialize.

The process does not end there : I was told by a Hungarian colleague - to who I had mentioned that a Hewlett Packard printer I bought in Europe was "made in

Hungary"- that this would soon be no more the case : those jobs are now moving to Russia and Ukraine, he said, where workers are paid still much less. What occupations remain outsourced to Hungary are of the more intellectual type, like research and software development, by companies like Microsoft, Intel and IBM.

The expression "*entreprises sans usines*" (enterprises without factories) begins to be heard in France, somewhat reminiscent of the "*sucking sound from the South"* predicted by Ross Perot when NAFTA, the North Atlantic Free Trade Association was debated in 1991 - referring to jobs from the U.S. that would migrate south to Mexico. Interestingly, the *Economist* published recently an article entitled *a sucking sound from the East,* referring to those same jobs moving from Mexico to Asia some 10 years later. A recent journal article paraphrased Winston Churchill in describing the situation with the words :

> " *A curtain has descended across Europe, On the one side are hope, optimism, freedom and prospects for a better life. On the other side, fear, pessimism, suffocating government regulations and a sense that the best times are in the past"*[59].

Interestingly, one hears those workers in Western Europe having seen their job outsourced to the East, claiming (often on the occasion of the those organized protests that regularly take place, often following the announcement of the closing of yet another factory that is "relocated" to Poland or Hungary) that ...." *we were not told about this when the virtues of a unified Europe was presented to us a few decades ago! "*. Which is, true, another illustration of the "*two cultures"* division that I have been talking about all along, biasing the information seen by the public, presumably also that used in official decision making.

Bearing in mind that globalization moves toward situations making sense when factors such as geography, human and natural resources, social environment and economics are taken into account then - other than for the "U.S. Empire" with its fragile overseas ramifications, other than for the "Pacific Basin Area" , where the presence of Japan is not to be forgotten and where truly Asian companies multiply (something referred to as "the third globalization" - definitely coming), one must consider the logic of a larger science-industry European community that - other than for those now in the Union - would include Eastern neighbors including those from the Russian Federation, though not necessarily, in fact most probably not within the same political entity[60].

In spite of having lost many of their scientists to greener pastures Russia has a significant well educated youth. In spite of economic difficulties, the country manages

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[59] an article (from Wroclaw, Poland) published in The Times (Trenton), Aug 8, 2004

[60] "*Russie , Union Européenne, chacune a besoin de l'autre"*. (*Russia, European Unnion, each needs the other)* in *Le Monde,* October 19, 2004 ,

to produce more than 200,000 science graduates a year. And their scientific competence is among the best[61]. The reasons why Russia is not ready to develop a fully fledged science/industry establishment of its own is in the structure of its society, an absence of appropriate institutions - a sequel of the communist regime and of the czarist regime before that, an absence not about to disappear soon[62].

The idea of a "greater (science/research/industrial) Europe" that includes Russia may appear far fetched to those part of the economics/politics culture, but it is already taking place with Russian scientists and engineers working on individual research projects in collaboration with the West. I was in the summer of 2004 at a conference in Brussels related to the mathematics of a problem of physics of interest to space exploration. Out of about 90 registered speakers, 26 were Russians coming from labs and universities located in the Russian Federation, against 19 from China-Japan, and only 8 from the US (several of them did not actually show up at the conference).

And the Internet Web is full of publicity inserted by Russian private firms that offer all kind of services - many, though not exclusively, having to do with computer programming. Interestingly, some of those firms maintain headquarters outside of Russia, one of them I found out recently in the US.

[61] *"A Renaissance for Russian Science"* in *Business Week* Augudt 9, 2004
[62] see Stiglitz (2002) - op.cit. .

## *Back to Asia*

Little are we reminded of the fact that before the 18th century, it was Asia and not Europe that was the largest contributor to the production and trade of manufactured goods. It was in the Far East that many technological innovations had seen the light, the compass, gunpowder, porcelain, the commercialization of silk, printing.

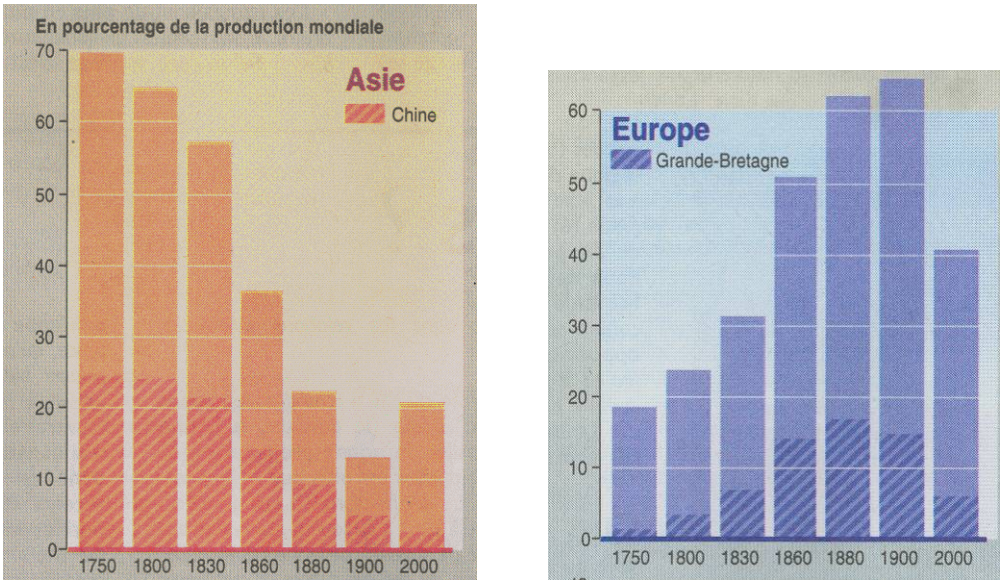


**Figure 21**

*EVOLUTION OF MANUFACTURED PRODUCTS (1750- 2000)*
*(In Percent of the World's production)*
*This 1750 -1900 (in fact up to 1950) period corresponds closely to that of the industrial revolution that gave a material superiority of Europe and the US - based largely on knowledge resulting of the 17th century European scientific revolution.. The decline in the 20th century ( a decline that began after WW II) came with the loss of this superiority associated,, among other factors, with the "giving away" of that knowledge to the rest of the world, in particular Asia.*

from Le Monde Diplomatique - Oct . 2004

Things began to change with the colonization of parts of the world in the 15th and 16th centuries by Europeans in search of spices and other exotic goods. By the 18th century, Europe's manufacturing was undergoing a radical increase brought about by the industrial revolution coming in the footsteps of the scientific revolution of the 17th. Europe had acquired a unique knowledge for building machines, for developing a sizeable and diversified goods producing industry. The North Atlantic was establishing a material superiority over the rest of the world by exporting, selling manufactured goods.

I like to quote in that respect from Jared Diamond[63], talking of New Guinea :

.....*"Whites had arrived, imposed centralized government, and brought material goods whose value New Guineans instantly recognized, ranging from steel axes, matches, and medicines to clothing, soft drinks and umbrellas. In New Guinea, all these goods are referred to collectively as "cargo".*

But this era of material dominance is in the process of being reversed. Indeed, with "*China*" replacing "*Whites*" and "*America*" replacing "*New Guinea*" , the above looks suspiciously like today's descriptions of the "Wall-Mart" phenomenon in the US.

With little governmental supervision or control, the West has given away, transported to the East much of the knowledge from which it had derived its material superiority - a superiority of the West that will end up having lasted possibly no more than a precious few centuries. The center of gravity of the industrial establishment is moving (back !) to Asia, to the Pacific Basin. If not inevitable, this must have been predictable to anyone looking at demographics in the second half of the 20th century. Knowledge is a commodity with little value of its own. It needs a human support, scientists, engineers, technicians, an educated population to be taken advantage of. It thus comes as no surprise that, from academic science to industrial know how, knowledge has been flowing from the aging West to the developing East and South East Asian countries attracted by its large young populations prepared to learn, eager to become part of a new and growing industrialized world[64].

As we have seen, other than for the traditional exchange of knowledge between academic communities and the exchange of students, much of this took place as part of the almost surreptitious offshoring of Western companies to the East (all of them new on the world scene, part of the new culture of knowledge, one may note). Examples provide striking illustrations of this migration of knowledge.

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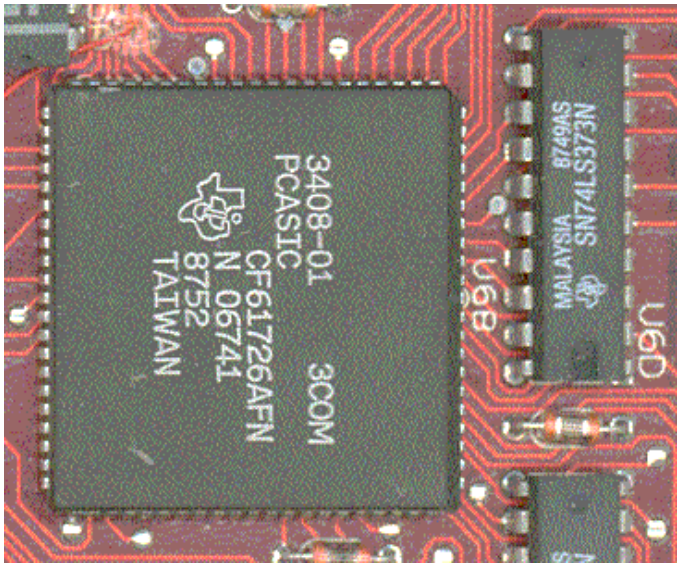
[63] Jared Diamond "*Guns, Germs and Steel" (1999)W. W. Norton & Co.*

[64] I am told by some of my Chinese students that those of the younger generation (those born in the 1980's) are not as eager to become engineers and scientists as were those born in the 1970's, the generation following the end of Mao's cultural revolution

As was mentioned before, the first transistor was created at Bell Labs, in the U.S. in the 1940's (John Bardeen, Walter Brattain and William Shockley won a Nobel Prize for its invention). The first computer chips, integrated circuit of a few square centimeters covered with interconnected transistors , were conceived in 1958 at both *Texas Instruments* and *Fairchild Semiconductor* (one of the first startup tech firms in Silicon Valley). The first computer chip had 32 transistors ( in 1964), a number that went to 64 in 1965, and the rise of their performance known as Moore's law was formulated in 1965 by (of course) Gordon Moore - that was later to become a co-founder of Intel, that world renowned company leading in computer chip development with headquarters also located in Silicon Valley, giving rise to the explosion of personal computers. Some of today's chips contain close to 100 million transistors on the same area. But much of the manufacturing industry derived from this invention is moving away from the U.S. and Europe. I have on my desk a discarded electronic communication circuit board, dated 1989 and presumably assembled in the U.S., covered with a variety of chips, 25 to be precise , of which a 5 were made in the Philippines, 4 in Malaysia, a few in `Japan, 2 in Taiwan ( many of them, ironically, bearing the logo of *Texas Instruments* with a map of Texas).




*Part of a circuit board (sold in the U.S.) that contains Texas Instrument computer chips made in Taiwan and Malaysia bearing the TI logo with a map of Texas - where the computer chip was invented forty years ago. This is not outsourcing (using cheap labor overseas) but offshoring (moving integral part of the company overseas : manufacturing chips is a capital intensive proposition).*
*The next step is in the appearance of companies with headquarters located in East Asia, no more the extension of U.S. or Western European companies.*

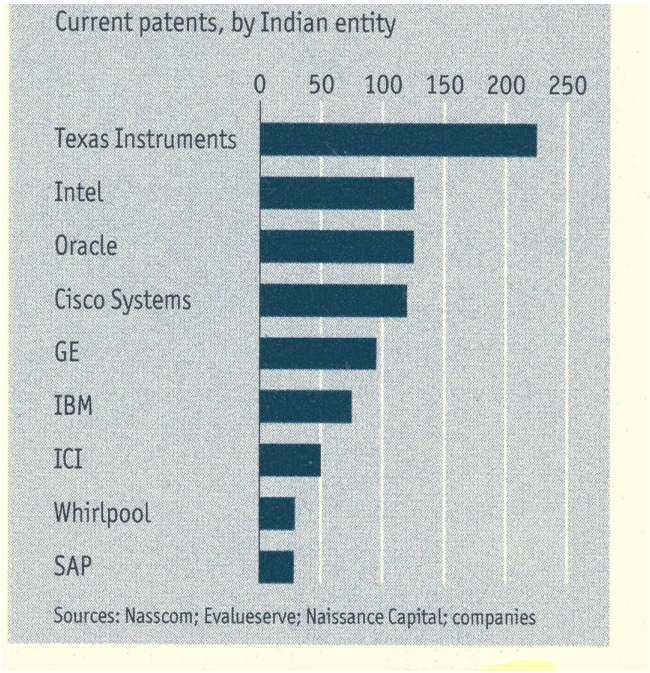
**Figure 22**

It is of course not only in the information technologies that this is taking place. My next example comes from nuclear engineering. While participating in a seminar at Purdue University a few years ago, I was listening to a paper presented by a member of the faculty describing a computer program for the simulation of the dynamics of nuclear power plants, the kind of thing one does to predict safety. I asked why he was doing that, given that no nuclear power plant was to be built in the U.S. in the predictable future (This was the case at the time – though it may well be changing soon). To which he answered *". Yes, but China is building nuclear power plants, and I am teaching this in Beijing* (at least I seem to remember it was Beijing) *where I spend most of my time"*. China, as well as a number of other countries in the world, was at the time building several nuclear power plants, while the accompanying steam generators and other related hardware were an important source of export dollars for the U.S..

This "Back to Asia" is also taking place in Europe, though sometimes in different ways. Faced with staffing difficulties, European companies have, true to business principles, searched for better ways to move ahead. Perhaps a harbinger of things to come is that instead of developing research laboratories in the face of rigid administrative restrictions, of internal divisions within Europe and immigration quotas making it difficult to recruit scientists, "outsourcing" research has appeared as an easy way out. There is the case of *Novo Nordisk*, a Danish drug company that solved the problem by simply opening a research division in Beijing where there is an abundance of skilled (and cheaper) graduates[65]. In the process, significant amounts of knowledge, know how is of course given away to get things under way. But there is no law against that.

*What this illustrates is the interesting fact that exporting knowledge is cheaper and easier than importing scientists.*

[65] P. Smaglik "Eastern Promises" in *Nature* 13 march 2003




*Patents filed in India by research divisions of Western companies located there, illustrating both the Western presence -- and the predominance of the U.S. on the World's scene. (ICI is a British chemical company, SAP a German software company)*

**Figure 22**

***centralized power vs. democracy***

One of the significant factors of China's success in industrial development is that it is not a democracy, and that the government may do such things as developing the coastal part of the country at the expense of letting peasant populations in other parts, those in the East far from the sea ports, in poverty. Quoting from a recent article : .... *China's governing elite, which at the top consists almost entirely of science-trained engineers, do not want uneducated, scientifically naive peasants determining national policies, including the allocating of resources. (One senior advisor asked, rhetorically, Would illiterate farmers vote for the information superhighway?). Measures that would be unquestionably beneficial to China in the long run might not be especially popular in the short run.…..*

> ……. *While "revitalizing China through science and education" is a favorite slogan of former President Jiang Zemin, he was equally adamant in promoting science and opposing Western style democracy*[66].

Other than for countries with totalitarian regimes like China, the weakening consequences of the two cultures syndrome has been evaded in smaller, or otherwise more homogeneous countries where there is a better grasp by the economics/political side in government of the importance of science/industrial research in development. Examples that come to mind are Japan, Finland, Sweden that have acquired a respectable position in technological accomplishments. I do not think it is by coincidence that all three of them are outside of the chaotic scene of international politics : those in government are by the force of things devoting more of their attention to the intrinsic economy and well being of the countries they run.

The importance given by Japan's government to industrial development and its impact on import-export was illustrated by the creation in 1949 of MITI , the Ministry for International Trade and Industry "*.... to provide government leadership and assistance ... for industrial productivity and employment [with] primary responsibility for formulating and implementing international trade policy...*" [67]. I had the occasion in the 1960's, to meet in Tokyo with members of the ministry and was impressed by the degree to which (in areas related to computers and electronics) they were aware of what the large companies in the country were up to, and to what degree national research laboratories could participate. There was more governmental concern for Japan competing for export against the rest of the world than competition for the internal market by domestic companies, as is seen for example in the US.

[66] Robert Lawrence Kuhn in" *Science as a democratizer*". American Scientist vol 91, September-October 2003
[67] www.fas.org/irp/world/japan/miti.htm --- MITI was renamed METI in 2001, the Ministry for Economy, Trade and Industry.

***education in Asia***

East and South East Asia have for the last decades of the 20th century depended on universities in the U.S. and Europe to help educate the best of their youth. But that will not necessarily continue to be the case. Chinese higher education is rapidly "normalizing" along American and other western models of the university. The country receives educational aid from UNESCO and many other international organizations and sources, including the World Bank which recently loaned China $14.7 billion for educational development[68].

Along different lines, a recent article in the New York Times entitled *"An American Degree, Made in Thailand"* (Education Life, January 18, 2004) reports that, following the visa restrictions imposed by the U.S. in the aftermath of the Sept. 11, 2001 attacks, a flurry of American colleges are establishing overseas campuses not only in India and China but also in places like Bangkok, Dubai and Tel Aviv, delivering American-accredited degrees.

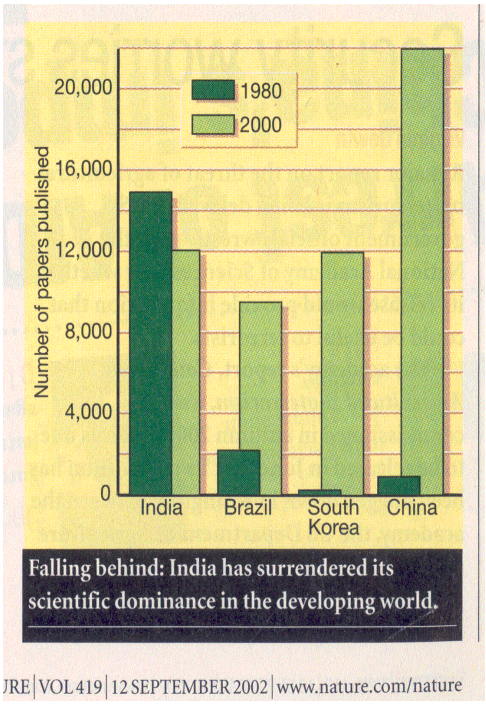



**Figure 23**
*The article in Nature – 12 sept 2002 where this graph appeared in entitled "India Agonizes over fall in Publication rate" The large increase in the number of papers out of China and South Korea must be attributed to an increase in the size of their educational establishment, new colleges, new universities to support their growing industry (and thus, among other things increase the number of faculty members that contribute to the publication of journal articles).*

*India, I am told concentrates on creating engineering schools, oriented more toward R&D than academic research.*

[68] Xin-Ran Duan in "Chinese Higher Education Enters a New Era" in " November-December 2003.

## *brain drain across the world*

Outsourcing manufacturing is not the only aspect of globalization that has brought about rearrangements in the geographic distribution of human activity on Earth. As we have seen, there is also the issue of what has rightfully called a " brain drain". By contrast with outsourced manufacturing, brain drain, as the name suggests, describes scientists (a category which includes students) moving to another country where conditions, intellectual, financial, or both are more favorable. The number of individuals involved is small in comparison with the numbers of jobs lost to outsourcing but the consequences are significant for some of those left behind, countries that see part of their educated population leave for greener pastures.

This has become an international issue, catching official attention in those countries losing their educated citizen to those places on Earth where science, research and development were flourishing. It came to the attention not only of the United Nations, but also of a number of non-governmental organizations, one of them the International Labour Organization (ILO) whose objective had originally been with the protection of workers, the support of workers organizations.

*Brain drain* is not an entirely new term, it had come to be used in the years immediately following World War II [69]. There was at the time a well established and funded scientific-industrial establishment in the U.S while economic conditions in Europe were not so good, opportunities to conduct research few. Whence a noted migration of scientists toward the U.S. at the time. This had been preceded by a migration of European scientists before and during the war – among them the best known being Einstein, Godel, Fermi and von Neumann - but it had to a large extent been motivated by the political situation, and not really part of what I am talking about here.

[69] The Webster dictionary says 1960-65, but I believe it had been used earlier.

*The largest numbers have been those of students coming mostly to the U.S. from China and India. Also to be counted, though in lesser numbers, are scientists, scholars from other intellectually developed countries in the world. Included in this are those from Europe, Russia, Israel migrating to mostly North America. - as of late a lot in areas related to bio informatics, the pharmaceutical industries and the like.*

*Then there are smaller countries for which the effect may be devastating. While hundreds of thousands of students and scientists leaving China and India represent only just over one percent of the educated population, smaller countries in Central and South America that are close to the developed, intellectual magnet represented by the U.S. such as Jamaica, Guyana. Close to 70 percent of their university graduates are lost to emigration.*

*Table 1. Population, Migration and Education Expenditure*

| | Population, millions | Migration rate | Total Expenditure on tertiary education, per student, international $ |
|---|---|---|---|
| Fiji | 0.79 | 21.3 | . |
| Guyana | 0.85 | 77.3 | . |
| Mauritius | 1.16 | 7.2 | 5080.9 |
| The Gambia | 1.22 | 59.1 | 3842.6 |
| Trinidad and Tobago | 1.29 | 57.2 | . |
| Lesotho | 2.06 | 2.9 | 18452.6 |
| Jamaica | 2.58 | 67.3 | . |
| Panama | 2.76 | 19.5 | 2006.1 |
| Congo | 2.78 | 0.5 | . |
| Uruguay | 3.29 | 3.7 | 2047.2 |
| Central African Republic | 3.48 | 1.7 | . |
| Costa Rica | 3.53 | 7 | . |
| Togo | 4.46 | 1.3 | 6572.2 |
| Papua New Guinea | 4.60 | 2.2 | . |
| Nicaragua | 4.79 | 18.7 | . |
| Sierra Leone | 4.85 | 24.1 | . |
| Paraguay | 5.22 | 1.9 | . |
| Benin | 5.95 | 0.4 | 2141.0 |
| El Salvador | 6.06 | 26.1 | 312.0 |
| Honduras | 6.16 | 15.7 | 1623.9 |
| Bolivia | 7.95 | 4.2 | 1176.0 |
| Rwanda | 8.11 | 2.2 | . |
| Dominican Republic | 8.25 | 14.2 | 1567.4 |
| Senegal | 9.04 | 1.6 | . |
| Tunisia | 9.34 | 1.6 | 3764.8 |
| Zambia | 9.67 | 5 | 2574.2 |
| Malawi | 10.53 | 2 | 9066.7 |
| Mali | 10.60 | 0.9 | 2573.4 |
| Guatemala | 10.80 | 13.5 | 1074.4 |
| Zimbabwe | 11.69 | 4.6 | 8783.9 |
| Ecuador | 12.18 | 3.8 | 1114.3 |
| Cameroon | 14.30 | 3.2 | . |
| Chile | 14.82 | 3.3 | 1670.2 |
| Syria | 15.28 | 3.1 | . |
| Mozambique | 16.95 | 8.6 | . |
| Ghana | 18.46 | 15.1 | . |
| Sri Lanka | 18.78 | 3.7 | 2476.9 |
| Uganda | 20.90 | 15.4 | . |
| Malaysia | 22.18 | 4.4 | 4901.7 |
| Venezuela | 23.24 | 1.6 | . |
| Peru | 24.80 | 3 | 680.5 |
| Sudan | 28.35 | 1.7 | . |
| Kenya | 29.29 | 9.9 | . |
| Algeria | 29.92 | 0.7 | . |
| Argentina | 36.13 | 1.9 | 2325.0 |
| Colombia | 40.80 | 5.6 | 2173.6 |
| South Africa | 41.40 | 2.6 | . |
| Korea | 46.43 | 5.7 | 881.0 |
| Thailand | 61.20 | 1.2 | 1618.3 |
| Egypt | 61.40 | 2.5 | . |
| Iran | 61.95 | 14.7 | 398.6 |
| Turkey | 63.45 | 1.4 | 3365.2 |
| Philippines | 75.17 | 6.6 | 560.1 |
| Mexico | 95.85 | 10.3 | 3459.9 |
| Bangladesh | 125.63 | 0.6 | . |
| Pakistan | 131.58 | 2.4 | 448.3 |
| Brazil | 165.87 | 0.6 | . |
| Indonesia | 203.68 | 1.4 | 387.2 |
| India | 979.67 | 1.1 | 2014.4 |
| China | 1238.60 | 1.4 | 1943.4 |

Source: **Carrington & Detragiache,1998**

**Figure 25**

(source S. Commander, M. Kangasniemi and L.A. Winters - "*The Brain Drain : Curse or Boon ? : a survey of the Literature"* - CEPR/NBER/SNS international Seminar, Stockhom, 2002)

It is not just from developing countries that there is a brain drain. Scientists from Europe, which includes those with advanced degrees in the bio-technology, bio-medicine area are leaving, in response to difficulties presented by administrative rigidity and a general lack of funds for research at home. One of their choice destinations is the U.S. where conditions are different. One hears of a *European Diaspora* mentioned in official circles of the European Union.

Some of the losing countries have been responding in kind. Resources have been poured by some into retaining native talent. Australia, for example, recently announced a two billion dollars package of research grants, tax breaks and new education funding to attract and retain technical talent. Japan has budgeted billions of dollars to increase information technology development and retain workers across Asia. And Taiwan, by expanding the scope of its graduate science programs and emphasizing the country's high-technology industry has lured back some 50,000 scientists who had left the country over the last two decades[70]

Interestingly, I found reference to an OECD proposal to introduce a "brain drain tax" to be collected by the U.N. from industrialized nations and redistributed to poor nations in the form of foreign aid , part of a package that, ironically, also included a tax on carbon dioxide emissions, a proposal highly decried by capitalistic interests, that also have groups and associations defending their interests , by the way[71].

[70].quoted from J.Glanz *"Trolling for Brains in International Waters"* - The New York Times, April 1, 2001
[71] R. Salsman *in "Capitalism magazine"* - http://capmag.com/article.asp?ID=1897

## *in closing*

There is food for thought if not puzzlement in the lack of vision found in statements about the future made by otherwise serious scholars, social science and economic pundits. John Kenneth Galbraith's 1958 *"The Affluent Society"* citing as a future problem that of keeping affluent populations occupied, and the Hudson Institute prediction that by the end of the century Americans would have 13 weeks of vacation, 147 work days and 218 free days a year do not, with hindsight, appear to have been not much more than pipedreams.

The results of C.P. Snow's plea (1959) saying that
*... we know how to heal many of the sick: to prevent children dying in infancy and mothers in childbirth: to produce enough food to alleviate hunger: to throw up a minimum of shelter: to ensure that there aren't so many births that our other efforts are in vain. All this we know how to do. ..... ."* did not do much to the developing world, in particular Africa where suffering has only increased.

To wit, the "Week in Review" section of the December 13, 2004 *New York Times* begins, under the somber heading of *"Farewell Africa"* with an article where one learns that *....."there are 340 million children in sub Sahara Africa living in marginal conditions"*. And in the same article *... "Unicef reported last week that half the world's children, a billion people face extreme deprivation"*.

The 1949 report to the United Nations General Assembly that said that 1.0 percent of the gross product of the industrialized countries given in economic assistance would see the underdeveloped world to self-sustained industrial development by the end of the century did not lead to anything of the kind. Which did not prevent the same optimism to be repeated half a century later. Quoting from Jeffrey Sachs, director of the UN Millennium Project [72] : *"When 147 heads of state gathered at the UN Millennium Assembly in 2000 [they] adopted the Millennium Development Goals to cut extreme poverty by half by 2015 ... promising to increase official development assistance (ODA) and technology transfer to extend the benefits of globalization and new technologies to the world's poorest people"*..... This Assembly was followed by the Monterey consensus of 2002, where *..."America and other rich countries pledged to "urge developed countries ... to make concrete efforts towards the target of 0.7% of GNP as ODA"*.

One may safely bet that not much more decrease of poverty around the world will follow those declarations than has been the case following the 1949 report to the UN General Assembly.

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[72] Jeffrey Sachs , in " *How to halve the world's poverty*" - The Economist's " *The Word in 2005"*.

That globalization would be coming was recognized by the Allies at the end of World War II, as testified by the creation of official international banking and trade institutions such as the International Monetary Fund, the Word Bank , in 1947 the General Agreement on Tariffs and Trade (later to become the World Trade Organization) to name a few. But much of what has actually taken place was influenced by things other than what can be controlled by those institutions. It has come from science, research and industrial development that reside to a large extent in academia and private business. This was illustrated by the appearance of multinational corporations that, other than for playing an often silent role in the world of natural resources and international politics, capitalized (literally) on willing human resources where they were to be found, mostly Asia, on knowledge, science, technology that had emerged in Europe and that could now be tapped, transported with little interference or control around the world in the search for profitable, easy to deal with environments.

We are faced with the paradox of a world of two cultures whose development is led in theory by an official establishment of policy makers and governmental edicts, but that is in reality led by the science/research/industry establishment that has its own rules, that gets away with little control thanks to the international nature of its operation.

Perhaps the most significant element that was unforeseen has been in a redistributions around the world,

-- of manufacturing and of some service jobs, using cheap labor away from the developed West, much of it in East and South East Asia,

-- of research, much of it migrating to Asia

-- of "knowledge" leaving its traditional home in the North Atlantic, that very knowledge that had come with the scientific/industrial revolutions of the 17th and 18th centuries in Europe.

We are not equipped to deal with the new problems raised by globalization, and I believe that the *two culture* division - that which has been the central point of this paper - has a lot to do with that.

There may of course be some truth in what was said by Jay Forrester in the 1970's in a deposition to the U.S. Congress : *It is my basic theme that the human mind is not adapted to interpreting how social systems behave. Our social systems belong to the class called multi-loop nonlinear feedback systems. In the long history of evolution it has not been necessary for man to understand these systems until recent historical times.* What he was promoting was computer simulation as a means of understanding, of studying the dynamics of those social systems. Some of the direction of research using computers as Forrester promoted does indeed take place, but it takes place inside of the science community and how much reaches those in the other culture, how

much it affects governmental decision making is limited, as the example of the UN meeting in Johannesburg I talked about earlier shows. There are other avenues of research that have been initiated with similar objectives, for instance those coming under the heading of "*Complexity*" with participation of eminent scientist including Nobel Prize laureates (for instance at the *Santa Fe Institute*). But how much they may accomplish is falling victim of the same *Two Culture* inescapable situation, is almost entirely ignored in government, economics circles and has also been minimal (the new economics theories of what is referred to as computational finance are really addressing a different class of problems).

--*--

Short of offering suggestions or recommendations for a panacea (I would not even dare to begin) I will close with a summary :

***About globalization*** : the " *uncharted road to globalization*" title given to this paper was suggested by the fact that globalization is guided by communities that by and large, belong to two cultures, essentially those of "economics/politics" on the one side, that of "knowledge/science/industry" on the other – two cultures that are both necessary but do not, in fact intrinsically cannot collaborate. Globalization shall continue moving ahead with a process of Darwinian evolution (as opposed to a rational planning ), resulting in a reality significantly different from what was conceived half a century ago (and is still all too often believed in) .

***About Asia*** ---- Asia was, up to the end of the Middle Ages (i.e. before the European scientific/industrial revolutions of the 17th- 18th c.) the leader in manufacturing and it is reclaiming its position not only in manufacturing, but is also in research, innovation, the creation of intellectual property.

***About America*** : ----- Research and manufacturing, while still under the American flag, come to be conducted by mostly foreign scientists and workers, on US soil as well as overseas, with a declining native American participation. Arguable comparisons with the rise and fall of the Roman empire have been expressed[73].

***About Europe*** ---- Since J.J. Servan Schreiber (1960's) and even before, Europe has tried to compete with an image of the US that does not exist (any more if it has existed at all in the past), that of a great industrial power where science is conducted, where advanced products are manufactured by American born scientists and an American workforce.

[73] e.g. E.Todd *op.cit*