European Institute of Technology - an Attempt of Euclidean Justification

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Europe is the cradle of universities. Yet - among the leading 200 or 500 universities European universities do not dominate - on the contrary. The European Union declared that its goal is to achieve high competitiveness knowledge-based economy by 2010 and to become sustainable knowledge society by 2025. How close is Europe in achieving that goal?

Key words: European Union, knowledge society, knowledge-based economy, R&D

1. Introduction

The following indicators represent useful assessment of how close we are in reaching the goal of building the knowledge society:

First: Education in general and higher education in particular, its spread and quality. Only some segments of higher education, specifically some departments and some faculties with European universities have increased considerably the number of students, secured that they graduate in a prescribed time, and maintained a high quality.

Second: The intensity of R&D, particularly the strength of frontier research, mission oriented research and curiosity driven research that generates the knowledge-culture. Even the Gross national expenditure for R&D - GNER&D in the EU (1.99% of the EU GDP) is below that of the USA (2.76%) and Japan 3.12% mainly thanks to much higher investment in R&D from industry. The values of GNER&D are, of course, not enough. The structure of GNER&D matters more, and it has been pointed out that output indicators are a better measure for assessing the allocation in R&D and the quality and potential of R&D.

Third, and most important: Strength of the three poles in the knowledge triangle: research - education - innovation and the intertwining of knowledge, economy, governance, often referred to as a triple helix. The triple helix in Europe is much weaker than in the USA, and Japan, China and India, each in its own way are making dramatic progress.

If one compares the number of all published scientific papers, one could conclude that Europe is comparable to the USA. However, the analysis of the top 1% of the cited scientific papers shows a gross imbalance: theEU contributes 37.3% vs. the USA with 62.8%. Similar results are obtained if one analyzes the number of Nobel prizes. One has to be more concerned when one studies the performance of the higher education. China is witnessing the biggest explosion of students' number in history: in 1980 only 2-3% of school-leavers went universities, in

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2003 it is 17%. The number of doctoral students in China jumped from 14,500 in 1998 to 48,700 in 2003. Only 21 % of the EU working population has achieved tertiary education compared to 38% in the USA, 36% in Japan, and 43% in Canada. With an average gross enrolment ratio of 52% Europe lags behind Canada (59%) and is much more behind t USA (81%) and South Korea (82%).

The declared policy is to put research and innovation at the heart of the EU policies and at the heart of the EU funding. Are these goals achievable with present university system in Europe?

What is knowledge society? Opposed to globalization that often has a negative connotation; knowledge society has in general a positive connotation - kind of motherhood and apple pie syndrome. However, the concept of knowledge society is fairly vague. It has been stated that the 20th century is the first "measured" society and indeed, various indicators have been introduced: e.g. gross domestic product - GDP, various improvements of GDP, human development index, globalization index, competitiveness index, environmental sustainability index, happiness' and life satisfaction index, and classification of leading universities. Though we accept Kelvin's dictum that the prerequisite of any meaningful discussion is the ability to measure, it is necessary to admit that we lack a coherent "theory" and that many measurements are not and cannot be useful. Good historical examples are measurements of force and motion performed by Aristotle, certainly a keen observer, and yet he has totally wrongly interpreted them. It is essential to measure, but it is not enough.

There are two approaches. One is to refrain from measurements until one develops a reasonable "theory", to avoid a possible Aristotelian mistake. The other is - and similar has been the road of modern science: measure, perform and collect many measurements, try to understand and develop a theory, measure again, and then improve the "theory". We will take the second approach. It appears as if collecting more "junk data" could facilitate formulating a better theory. (Again a historical example could be useful: contemplate whether Kepler would ever formulate his law of planetary motion if the data at his disposal have been as accurate as they are today - and of course very far from the ellipse.) To facilitate this approach we will try to precisely define concepts we are going to use, and we will formulate assumptions and goals. From these assumptions we will derive their consequences, which then can serve as preliminary benchmarks in assessing how far we have progressed towards building a knowledge society and whether a specific institution/instrument/action has a useful effect in building a knowledge society. This is a humble attempt to follow Baruch Spinoza's formulation of Ethics (geometrically demonstrated, lat. "Ethica More Geometrico Demonstrata").

We attempt to discuss education, precisely the higher education system and to outline the solution - establishing European institute of technology - EIT - using the Euclidean approach: postulates, definitions and theorems. Of course, it is necessary to appreciate that while in geometry the definition of e.g. the point cannot change, here definitions do change.

1.1. Assumptions

Definition 1: Wisdom is knowledge + values.

Definition 2: Knowledge is existing science, humanities and technology, ongoing and planned research and development, innovations, ideas, and also language, literature and art, as well as system of education. Totality of all of these is understood and contextualized only within a specific cultural system, implying constant changes and development of each culture, since knowledge constantly changes.

Definition 3: Knowledge society is the society where knowledge dominates all spheres of life and activities.

Definition 4: Freedom means freedom to think, to create, to discuss and to act. It implies diversities: biological and cultural. Freedom implies differences of opinions, heresies, disagreements and disobedience. Freedom implies tolerance toward other opinions and actions, but intolerance toward any form of authoritarianism, toward ignorance, carelessness and inactivity.

Definition 5: System of education makes possible that individuals and social groups transfer, assimilate and accept existing knowledge and values and that they can produce additional knowledge and values.

By "Definition 5" all research institutes and centres regardless whether they are governmental, industrial or any other form of public or private institutions are part of the educational system. System of education is at the same time an engine of rapid changes and anchor of stability and inertia. This Janus' face of the educational system, which is so clearly displayed in the behaviour of most universities, puzzles and disturbs anybody who tries to "improve" the system of education from outside.

Postulate 1: Knowledge is the inexhaustible resource, and it increases by sharing.

Postulate 2: Knowledge society is imperative since all other known resources are finite and exhaustible.

Postulate 3: The values are freedom and solidarity/compassion/love; specifically - increase of freedom, of human options and of compassion.

(Caveat: There is a tendency of increasing the number of values as if having more values implies higher morality. Many such "values" are mere theorems and corollaries. Others are true "new values" but not necessarily compatible with and often in conflict with other proclaimed values. The set of values has to be self consistent.)

Postulate #3 constantly increases the Pareto optimum and enables more and more interactions among individual human beings, among social groups and between an individual and social group to be win-win games. The basis of Postulate #3 is the characteristic of knowledge to always increase, its cumulative nature.

1.2. Consequences

Globalization and rapid changes are science generated.

Theorem 1: Knowledge resides in people. Therefore, people are the essential resource in the knowledge society. **Each person, all persons**, regardless of sex, age, health, capabilities, with all their diversities - **are the essential resource**.

Any sort of violence is incompatible in the knowledge society.

Theorem 2: Since knowledge resides in people, it demands free and creative persons, and since it is inconsistent with disregard of human beings, knowledge society leads to increasing wisdom. **Human being in a knowledge society is the value**. Theorem #2 augments and merges into Postulate #3.

Theorem 3: Knowledge society intertwines knowledge, free market and governance.
Specifically, it intertwines universities, industry and policy and decision making (triple helix).

Though most breakthroughs occurred within a specific scientific discipline (e.g. quantum theory and theory of relativity within physics; theory of evolution and DNA discovery within life science; importance of free market in economy; this does not diminish the importance of cross-breeding, e.g. Malthus' theory stimulated Darwin, and Roentgen discovery of x-rays created totally "new" medical science), most of the problems we face today are inter- and trans-disciplinary, and it is prudent even necessary to recognize that market, production sphere and governance can stimulate not only mission oriented but curiosity driven research. The crucial requirement for the knowledge society is the knowledge intensive innovative governance and social structure.

Theorem 4: Knowledge society assures and is responsible that people have full health care, full and permanent education, employment and possibility and stimulation for socially and politically active life. Education, health, employment and capacity for social and political activity are human rights.

This seems like a tall order that is impossible to accomplish. However, anything less is tantamount to a destruction of the crucial resource - human being.

Theorem 5: Knowledge society cannot be a set of islands in the sea of mediocrity - **everybody** has to be permanently educated. Quality of education has to be maintained at a very high level and has to be constantly improved.

Theorem 6: System of education has to be intertwined with the employment. The employment guarantees income, insurance and health protection.

Theorem 7: Wisdom and specifically freedom and creativity should not be suffocated by rigidity, specifically not by rigid education (reference: A. Einstein's complaint about education) - on the contrary education has to increase freedom, creativity and wisdom.

Corollary 1: European system of education has to enable creative employment at each level. First employment should not be later than at the age of 23. Several postgraduate studies (one to three years dominated by education and research at the age of 45-50 and at the age of 60-70) should punctuate the permanent education system. Education and employment are not two separate segments of person's life. Indeed, they overlap. Education for MDs is a good example how even today the Medical school graduates are being initiated into their jobs, and they constantly have to learn.

Corollary 2: The values: freedom and compassion are faster and easier accrued if the system of education assures and guarantees mobility of those who educate and those who are educated.

Corollary 3: Since each person will change her/his profession many times throughout their lives, there has to be more demands than supplies. Since less and less jobs are required in agriculture and manufacture, since humans are successfully replaced by robots, the jobs that only human can now do are: creativity, failures and recoveries. New ideas are at the root of new jobs, of the job-led growth.

Corollary 4: Knowledge society results in a socially cohesive society abundant in all diversities.

Half a century ago, when the dominant resource was oil, the statement "Ideas are mine, and

the gasoline is yours" had to be associated with a cheater, exploiter of those who are naive - Ostap Bender, a charlatan character from the books by Iljf and Petrov. Today ideas are essential, and it does not even matter whether they are right or wrong, it is useful that they are original ideas and all of them will eventually generate good ideas.

Just like in the animal world competitiveness and cooperation coexist in a knowledge society not as rival forces but as two aspects of interactions.

The Bologna Process accepted by most of the European countries is an attempt to operationalise and implement some of the above theorems and corollaries. However, there is a constant danger that the Bologna Process can deteriorate and turn into its own negation. Therefore, let us reemphasise what the Bologna Process is all about in two points:

I) Human resources development assuring education, skills and wisdom so that everybody - at least in a specific age cohort - becomes employable and employed by a certain age. The dropout rate is reduced to negligible and the process is accomplished in a specified time interval and

II) Education adequate for continuous permanent education, which means a lot of various "literacies": languages, mathematics, ICT and basic understanding of essential features of all sciences, humanities and technologies.

2. A Role-Model Which Is Not

From "Theorem 5" it follows that education has to include everybody. A bottom-up approach of a modern version of "enlightenment" appears as a good approach. However, it is not adequate for building a knowledge society, because of the following reasons. First, it is not sufficient to provide basic education, kind of more general literacy (i.e. including information-communication literacy even with a $ 100 laptops as will come on the market in 2006), since knowledge constantly increases (doubling time is less than 10 years) and permanent education is a necessity. Second, a significant part of education is self education, and "enlightenment" does not assure it. Therefore, a different approach is necessary. Instead of a bottom-up we propose a top-down approach - an outstanding institution of higher education (instead of educating directly many persons who are currently undereducated we propose to educate the top-higher education. Certainly this approach is much easier). Such an institution will be an excellent role-model of inspiring and stimulating self learning. Obviously, such an institution will educate a very small number of persons but they can serve as a seed. Top research universities in the world are models of such institutions.

However, such institutions do not guarantee the fulfilment of the "theorem 3". It is claimed that reasons why the European universities are not as good as American and now even Japanese, Chinese and Indian universities are their inappropriate dependence on government and weak influence on governance and free market.

In the knowledge society R&D and education are not only the responsibility of the government, but also of the entire civil society, specifically of industry, agriculture and service sector. All support: human resources and financial resources have to come from all of these sectors. In order to be successful, R&D and education have to be supported from a multitude of sources. From "Theorem 3" it follows that higher education institutions intertwining science and technology - knowledge in general with industry and more generally business and economy, are a convenient engine building a knowledge society. Such institutions have been developed in Europe (ETH in Switzerland), and in the USA more than a century ago. Outstanding examples are MIT and Caltech. Can these institutions be a role-model for Europe today?

If one would attempt to define and describe Europe in a sentence, it could be said that *Europe is the richness of cultures that created democracy and science that now dominate the entire world.* Though science is universal and international, it is developed within a specific culture, and carries the mark of that culture and thereby, it strengthens that culture. Since - as has been shown by numerous historians - all cultures contributed to science, it is necessary that such outstanding institutions of higher education are in several European countries, preferably in all European countries. Then, two problems emerge. First, can a very high quality be guaranteed, and second, do we have enough resources, not only financial. Even if both problems could be overcome, such a system of independent "European institutes of technology" - EITs would not assure mobility, would not guarantee increase in wisdom that mobility and exposure to different cultures do.

Copying the model which is a century old is hardly a good prescription.

Recently in Japan the National Institute for Advanced Industrial Science and Technology has been established based on outstanding research/ higher education centres throughout Japan. We propose a similar model.

3. Network

We propose to establish a network of leading personalities/groups/centres in Europe, which will from the start, involve business/industry/agriculture and aquaculture/environment and policy- and decision-making. An attempt was already made in early 2000's proposing the South-East European Institute of Technology (SEEIT), designed to be a network of centres and individuals aimed at 1) nanosciences and nanotechnologies including e-science, 2) marine research, 3) sustainable development and 4) life sciences. There is no reason why such a network should be geographically defined, and limited to those four areas. During the last few years several important developments occurred. For instance, Mediterranean Institute for Life Sciences in Split - MedILS, Croatia, and International Postgraduate School Jožef Stefan in Ljubljana, Slovenia, have been established and started to function. It is desirable to consider both of them in the proposed network. In addition, it would be better to extend the original SEEIT proposal to include persons and centres outside of South East Europe. It would be excellent if CERN, an eminent centre for curiosity driven and mission oriented research, but also the place where numerous new high technologies have developed, notably www, could be involved in this network.

The network is formed as a combination of the bottom-up approach satisfying the following criteria:

1) high quality of individual researchers and of a specific small group of researchers already involved in research, technological development and education;

2) assurance that research-economy-governance are intertwined (the triple helix)

3) network should have at least five nodes, each in a different European country; and

4) it is desirable that topics of research, technological development and education are not restricted to scientific disciplines, but problem solving oriented, and thereby complementary to the existing structure of most of the leading universities, and a constant top-down pruning of the network - no node is considered to be permanent: new nodes could be added, and even some of the "founding centres" can stop being nodes of the network. Besides standard independent quality assurance, the quality is assessed also by the success of the education: number and quality of applicants, and the employment that graduates get.

Education transfers and develops knowledge and values, and therefore, according to Definition 1, **Postulate 3**, and *Corollary 2* the model that existed in Europe throughout 13th – 16th centuries, where for instance, at the University of Paris most of the students and professors were foreigners, and where a person would start his (at that time it was only males) education in Prague, continue in Bologna, then go to Oxford, and finally would complete it in Heidelberg - is the best model for providing as much wisdom as it is possible through the education limited to a given period of years. Obviously this model has to be built-in the EIT. An EIT network we are proposing includes this model from the start. Namely, all staff of the EIT has to spend at the initial stage at least 40% of their time in other nodes of the network, and the node is often a combination of researchers/staff from different countries, and all students have to attend lectures and do research in at least three different nodes. As the network develops successfully, it is envisioned that mobility and cohesion increase.

4. Why Is a Network a Good Model?

Relevant demographic data are given in Table 1.

Table 1 show that in absolute numbers and percentage-wise European workforce will decrease. While in 1995 European workforce represented 14% of the world working-age population, it will fall in less than 20 years from now to barely 9%. Various estimates demonstrate that EU 15 would have to accept between 68 and 150 million of new immigrants to match the demographic losses. If we take the figure of 100 million, then it implies that at least one fifth of the workforce would be due to immigrants, and it is very difficult to successfully integrate them in a specific country economy. Japan will also face significant labour shortage and will have to accept about 25-30 million immigrants. The US and China

/year	1995	2010	2025
Europe	488 millions	496 millions	452 millions
world	3.5 billions	4.5 billions	5.3 billions

Table 1: Decline in working-age population in Europe vs. increase in the world

year/	over 65/million	working-age population/million	percentage
2000	71	303	23%
2030	110	280	39%

Table 2: Persons over the age of 65 in Europe

will be almost self sufficient lacking only 17 and 10 million, respectively. However, India will have a surplus of 47 millions. Obviously massive migrations of people and jobs will occur. There is a gross mismatch between needed and demanded skills and the will and the possibilities of job-seekers.

In the year 1985 105 million of graduates live outside country of their birth, while in 2000 that number increased to 175 million, i.e. 67% increase compared to a 26% increase in the world population. Among emigrants dominate UK graduates with 16%, while France is the bottom of the EU15 list with 3.4%.

Presently the USA has a shortfall of 126,000 nurses and it is estimated that by the year 2030 will lack 200,000 MDs and 800,000 nurses. The lack of ICT specialists in Germany is well-known. In Austria 42% of enterprises face labour-skill mismatch. In India only 5% of the workforce has formal vocational training. These data show the failures of the present educational system, but also demonstrate the ingenuity and the capability of the free market citizens and governments in providing at least temporary solutions, not necessarily adequate.

Table 2 shows the number and percentage of persons in Europe over the age of 65.

A specific problem in unemployment is the fact that youth unemployment is extremely large. For instance, it is 11% in the USA, 28% in France, 37% in Croatia and 50% in Spain, the world has 14% youth unemployment. The high unemployment among youth can hardly be explained by either not being able or of not having adequate skills.

5. Conclusion

The significant feature of this proposal to build a European Institute of Technology - EIT as a network of existing first rate individuals/centres is the short time interval necessary to implement it and a rather low cost to start the system. We estimate that the system can start within one year after the decision is made, since human resources exist and since the existing infrastructure necessary to start the EIT already exists in all of the nodes that will be chosen. Of course, improvements in the infrastructure will be necessary, particularly in ICT, but that would be either relatively small or it could wait until the entire concept is validated. We estimate that as little as 50 million euros can be the initial allocation and that after 2-3 years the success of the proposal can be evaluated and then decided whether and how to continue it.

This model does not hinder any other proposal for the EIT, regardless whether it is based on one site or if it is a network. If it is also a network a decision could be to merge them and possibly by mergence even improve its quality, or to try with two networks and learn from two different experiences.

The extent to which a proposed network assures the intertwining of business (market)-governance-research is demonstrated from the start by the contribution for the establishment of the network provided by the environment (local/regional/country) of each specific node in the network.

A network as opposed to a single site EIT is based on various cultures and nations deriving its value from their richness and varieties, and in return enriching the wisdom of everybody participating in the EIT. While the cost of starting a "network EIT" is quite modest, its economic impact in all countries involved would be quite large. The more each host country contributes to a "network EIT", the more its economy will finally profit.

There is ample evidence throughout history and in many countries that international science-technology centres have been a major driving force of development. A "network EIT" actually means a successful international science-technology centre in each of the countries hosting one or more of the nodes of the network.

In a way a network comes closest to the "enlightenment" approach starting by educating the educators-researchers.

In spite of significant successes that have been achieved, the social cohesion has not improved. Often the gap has widened. Taking into account all available resources a "network EIT" is a rather simple way to quickly and efficiently improve social cohesion in Europe.

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