An integral model for interleaving 21st century Education with Career and Life Long Learning. Introduction to historical scope and design rational

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Abstract: The current trends of disfavoring statistics for technological education in EU and USA, are not to be regarded as an issue of isolated origin and cause, but rather as a culminating sequence of consequences stemming from structural deficiencies in the career development, curriculum inadequacy and competency, along with a non efficient and rigid link between academic education and enterprise/industry.
The hereby briefly outlined EUEDOS model (www.euedos.org - European University Enterprise/Education/Employability Databases Organization System), has been initially officially presented and proposed under the European University-Industry Network (www.eui-net.org). This preliminary study, introduces an integral 3-layer roadmap for implementing an effective and pragmatic delivery, of a technological model able to interleave and render an individual's employment and academic profile, as inter-nested to his/her life-through education. It can be readily applied as a complementary activity to standing policies and institutional structures. A robust technological framework is further introduced able to act as an effective roadmap for Life-Long-Learning activities, as well as sustain the accumulated wealth of the life-through experience assessed by the individual. On the technology framework aspect, this model is realized as a set of next-generation distributed repositories/depositories, nested under a flexible low cost grid (as based on common non-brand hardware platforms) for allowing the knowledge built-up on an inter-institutional cycle of sustainable cooperation. The emergence of thematic networks and "technology leagues" that should spring from such a fostered activity, will form the basis for the new enterprise model, expectedly a broader scheme of cooperation of experts focused towards project specific activities with innate potential for acute innovation generation. The paper will also provide a brief overview of deductions and directions after three years of rendering the project's exploratory activities

Keywords: *Educational Technology, European University-Industry Networks, Employability, Lisbon Strategy, Distributed Databases, CDOs, Career Development Services, European Education and Employment Policies, repositories, thematic networks, Engineering education*

1. Introduction

The decisive negative shift in engineering as a first degree selected discipline, is about a decade long. Mostly affected are the USA and EU economies, although the magnitude and causality are not identical in both cases.
Although identification and tracking of the long term repercussions pertaining from a systematic educational underperformance in the MST domain (Math Science Technology), is particularly complex and difficult –particularly for the developed world societies, the strategy for assessment and restoration of students interest to MST and engineering, is neither unique, nor identical to previous realms in education. Furthermore, a deeper examination of comparative worldwide trends, may reveal routes stemming from more intrinsic social tendencies and notions. Separating tacit from explicit deductions in examining such social trends, is essential for safeguarding success from any attempted strategy and policy. Considering the exponentially rising importance of the engineering discipline in the 21^{st} century, it becomes particularly evident that eventually implemented strategies must guaranty

not only long term efficacy, but assert sustainability and social endurance during the perilous years to follow.
The cardinal scope of this essay is to propose and highlight a certain candidate model of maturity in assessing long term issues, via use of feasible and available technological infrastructure. However, it is necessary to a certain extend as well, to reveal standing or detrimental and persistent problems, hindering progress. Although a verbose elaboration is well beyond the aim of this essay, there is no effective and prominent way to address an issue on educational technology or employment perspectives, without respecting the original social trends and demographic evidences, serving as clear crisis indicators. Consequently, the following chapter will resume some of major historical indicators that shaped the rational and vertebrate design of the EUEDOS model.

2. Engineering as a discipline and practice in the 21st century: a nested issue

This chapter will attempt a simple statistical history interpretation of the engineering academic and employment evolution of the last 20 years. Via clustering to subsidiary chapters, an analytic model for the primary components/factors of the current situation, will be hopefully elucidated. Deductions from each cluster will be used as to correspond with the specific modules of the EUEDOS model.

2.1. Supply & Demand vs Early Anticipation. The educational analogy

Contemporary higher technological education is primarily aligned towards a direct interpretation of the economical supply and demand model. That may have served adequately when a loose and rather explorative relation was the prevailing feature, between these two complimentary values of our politico-economic systems. However, when we discover that issues previously regarded as trivial, subsequent, or even subservient to predominant economic growth vectors, may twinkle into a much higher priority for our welfare and even financial perseverance as a society, then we may end up in a disposition. As an example, several of the environmental, climate driven, energy resources depletion problems, themselves a cardinal affair of engineering and technological struggle, have been repeatedly regarded as externalities to economo-technical evaluations, just a decade ago**. *Figs 1 a & b***, demonstrate a potential relation between these two issues, as well as revealing this trend in engineering decay as profession and as a subsequent repercussion statistical academic lag. The statistics do also reveal –at least to a certain extend- the potential cause to this lag, being a disproportional favouritism to other disciplines, as is –f.e.- life sciences. These deductions may reveal the analogous of an "ecosystem behaviour" for our educational system as well. The notion of shear system growth as we perceive it in economic theory terms so far, may had little to do with assessing and encompassing such a behaviour so far.
Trends of this magnitude, also reveal our educational system's response and agility. This is an issues of primary concern, as it also reveals intrinsic issues in our societal structure. To a self-imposed level, we would have expected that our educational and research driving mechanisms are the profound receptors of change and the guarantors to timeous adaptation. ***Figs 1 a to c***, actually suggest that this process of recording, comprehension and reaction, may -for a multiple and nested number of reasons, be quite long. A delay of 15-20 years until the highest educational discipline of Phd level is affected, may also effect serious social damage besides the more discernible economic and academic penalties. However, this should be regarded as a phase shift manifestation and, practically, an implicit issue which would take longer to analyze. The apparent lesson to consider in the current case, is that a restoring action in engineering education should have been realized and implemented earlier, since the dynamics of our welfare, now on a geopolitical scale, would have been significantly benefited from this resource, as vertebrate for addressing our competence and several 21st century problems. The less apparent notion, is that a much more efficient method for recording and steering change, should be immediately developed and implemented in the educational / employment domains.

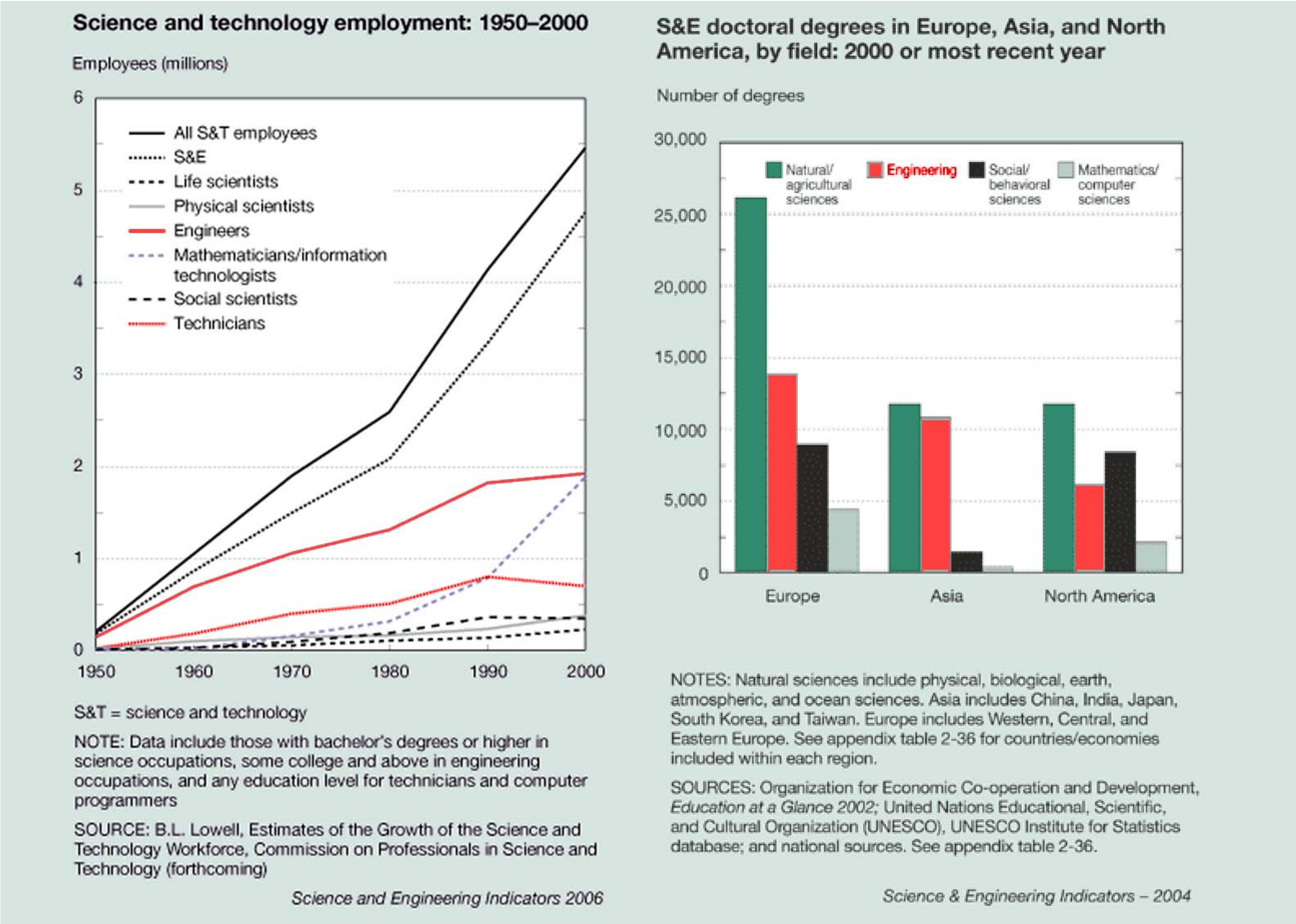


Fig. 1 (a, b) USA Engineering employment trends decline, comparison of Engineering Doctoral percentages in Europe, Asia, and North America

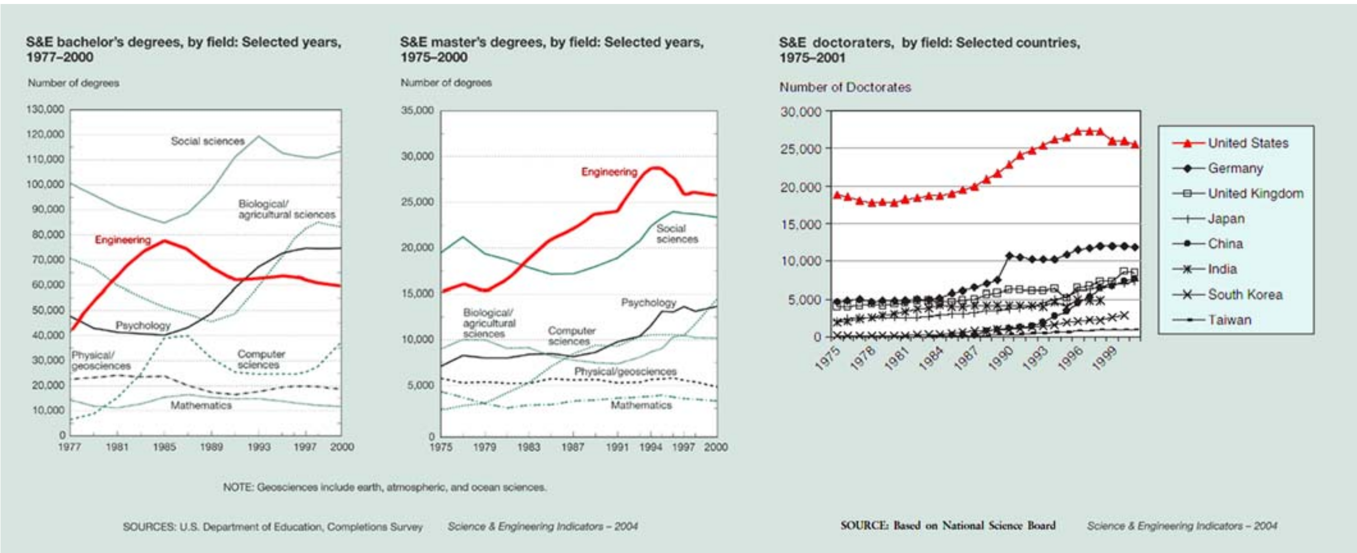
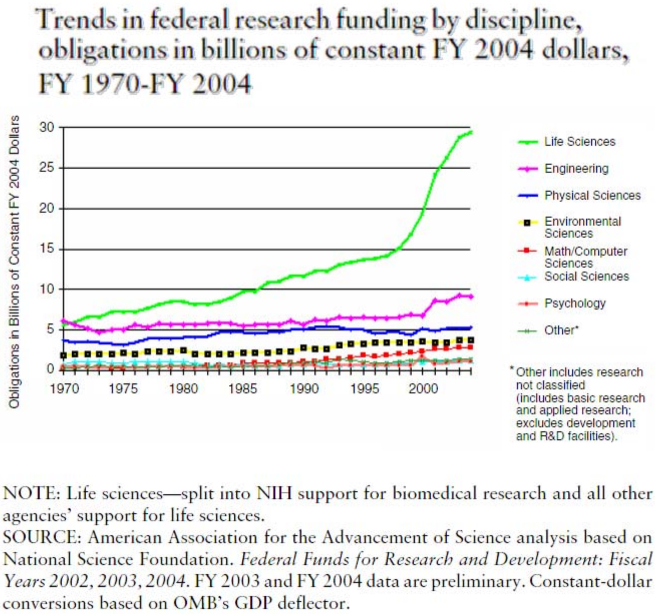


Fig. 2 (a, b, c) USA Engineering education degrees volume decrease and time shifted repercussion to the ascending academic qualification, 1975-2001

2.2. Educational policy as a stable social and technological investment

The now enlarged European educational system, collectively appears to be less prune to the mere supply and demand rules, particularly in the tertiary level, whilst more susceptive to the cultural and intrinsic issues that govern the pluralistic societies. Economic adversities and strict national fiscal policies, progressively hinders our determination to support generous and effective funding for education, with notable exceptions from the Scandinavian domain. Despite what is oppositely claimed, and as aforementioned in 2.1. chapter, the educational return on investment is a relatively explorative and long term process. Difficulty in accounting for immediate tangible results and obtaining mature feedback, does not only obscure our policies, but also attenuates our faith that our primary investment plans should target education.



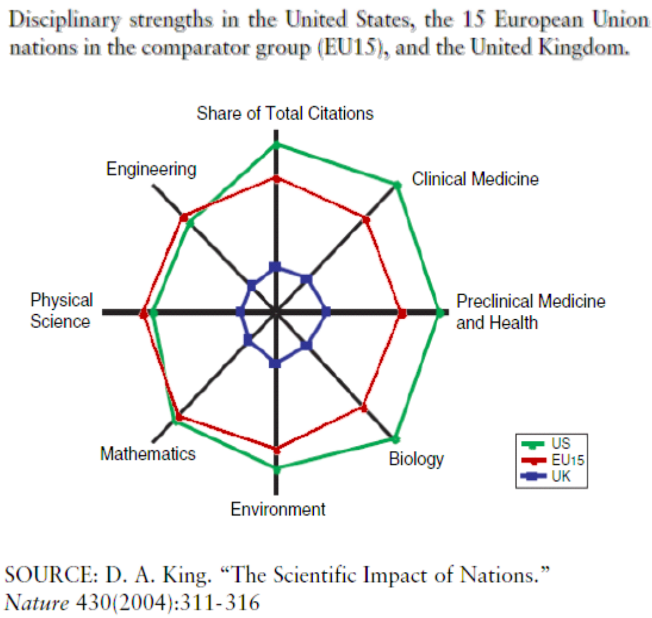
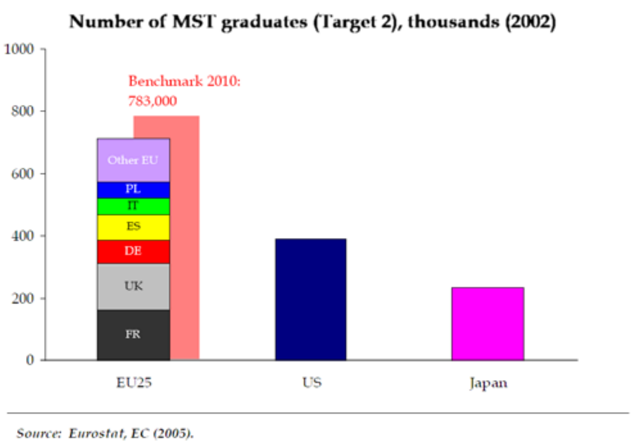


Fig. 3 (a, b) Correspondence between Life Sciences & Engineering disciplines in USA federal research funding and subsequent research competency indexes, in EU15 & UK. EU retains competency in Engineering, but lugs in Life Sciences. 1970-2005



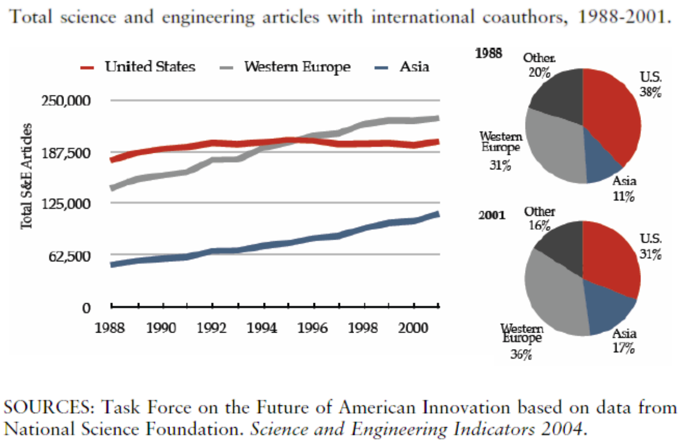


Fig. 4 (a, b) MST volume performance and correspondence to volume of engineering research, as a comparison between EU25, USA and Asia. Higher volume of technology graduates in EU, is progressively reflected to research advantage. 1988-2001

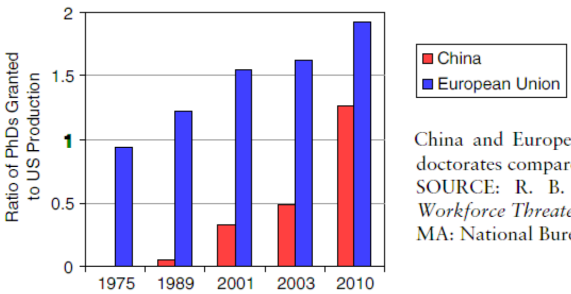
Figs 3 a, b, indicate that a fairly proportional relation to investment and education and return on investment, as can be substantially evaluated in research and innovation potential, does exist. It is –expectedly- a long term process, but it has a fairly corresponding and long lasting benefit. ***Figs 4 a, b***, indicate that there is also a robust relation between educational quantity and quality indexes, as a safeguarding indicator that an intensified research potential requires a sizable "ecosystem" as to flourish. Educational welfare is a well cultivated process in many aspects, besides enabling investment.

Americans tend to dismiss such indicators with the notion that USA remains the prime innovator in the world. Yet, 48 percent of the u.s. patents granted in 2004 were of foreign origin, according to the u.s. Patent and trademark office. That share has been increasing steadily for years — from 18 percent in 1964, to 33 percent in 1974, to 42 percent in 1984, to 43 percent in 1994. USA is no longer alone in understanding and capitalizing on the direct relationship between innovation and economic growth. Many countries now are focusing aggressively on turning their schools and industries into hotbeds of creativity, imagination and innovation — the areas in which economies will win or lose. However, the issue of managing the quantitative aspects of investment in education as a total, as well as a focus mitigating unemployment, remains a cumbersome issue for EU.

Technological competency issues, do no longer remain the arena of EU, USA and Japan. Rising economies in China and India for instance, are investing highly in the "brain capital" commodity, soon reaching a comparative research potential to that of USA and even EU.

In India, higher education currently enrolls more than nine million students (about 10% of the relevant age group), with almost 20% of students in engineering and medicine. More than 300,000 students graduate each year with qualifications in science and engineering; In both cases, the annual volume of graduates is similar to U.S. degree production in these fields.

China, on the other hand, has already been reaching research potential indexes equivalent to USA, whilst rapidly bridging the gap with EU (***Fig 5)***.



China and European Union production of science and engineering doctorates compared with US production, 1975-2010.
SOURCE: R. B. Freeman. *Does Globalization of the Scientific/Engineering Workforce Threaten US Economic Leadership*? Working Paper 11457. Cambridge, MA: National Bureau of Economic Research, June 2005.

Fig. 5 Science & Engineering doctorates trends produced in China & EU, as a comparable volume ratio to those produced in USA.

The key deduction here is, that research potential, should not be seen as an antagonistic asset or competency, neither being anymore regarded as an issue subjected to wider political motives. Simplicity of expression should apply to issues as important as this, particularly under the realization that in the coming years, we will require a worldwide quantum leap in the research capacity that will be required towards sustainable development. A new generation of international, inter-institutional cooperation could be the apparent general policy to address such a demand, and a new generation of inter-institutional, commonwealth knowledge repositories could serve as one of the technological frameworks needed for this endeavour.

2.3. Educational policy as a stable social and technological investment

The **total investment in higher education** in the EU is about **1.1% of GDP**, which is on a par with Japan, but below the levels of key competitors such as Australia (1.5%), Canada (2.5%), the US (2.7%), and Korea (2.7%). The differences in total investment are mainly explained by differences in the level of private investment. **Private investment in higher education** in the EU amounts to less than 0.2 % of GDP, compared to a weighted OECD average of 0.9%. Private investment in higher education in the US is more than ten times higher (1.8% of GDP), and in Japan about four times higher (0.6%) than in the EU . This situation has most certainly affected European universities' performance in world-class research, with a lower share of scientific publications, patents and Nobel prizes than US institutions ***(Figs 6 a,b)***.

The higher Education funding gap

	Public	Private	Total	Enrolment
EU 25	0.9	0.2	1.1	52
highest	1.8	0.3	1.8	22
lowest	0.8	<0.1	0.9	85
US	0.9	1.8	2.7	81
Canada	1.5	1.0	2.5	59
Japan	0.5	0.6	1.1	49
S. Korea	0.4	2.3	2.7	82

SOURCE: Universities, core actors in achieving the Lisbon Strategy's goals
Ján Figel'
European Commissioner for Education, Culture, and Multilingualism
Brussels, 10 February 2005

Number of graduates (ISCED 5 and 6) in mathematics, science and technology (1000)

Region	Tertiary graduates	MST graduates		Growth per year in 2001-03 (%)	New PhD graduates,
	2001	2001	2003		2002
EU25	2956	681	740	+4.2	85
USA	2174	380	431	+6.5	44
Japan	1068	233	230	-0.6	14
China	1948	464	810	+32.1	13
Russia	1240	n.a.	225*	n.a.	n.a.

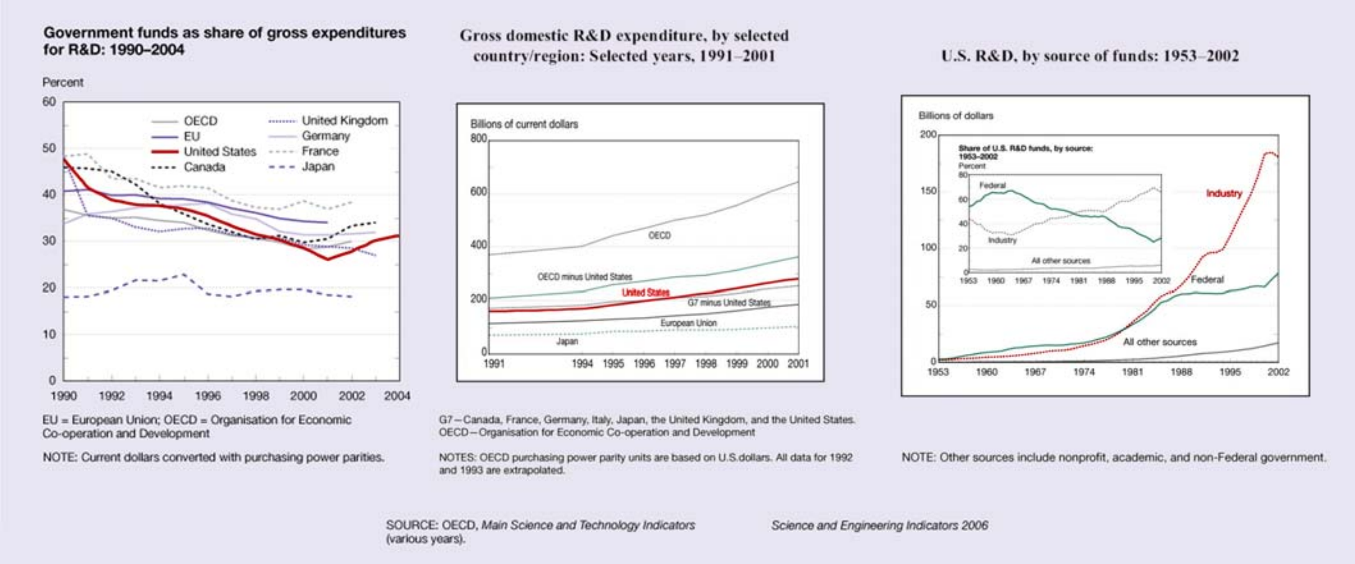
* data for 2002

Education and Culture

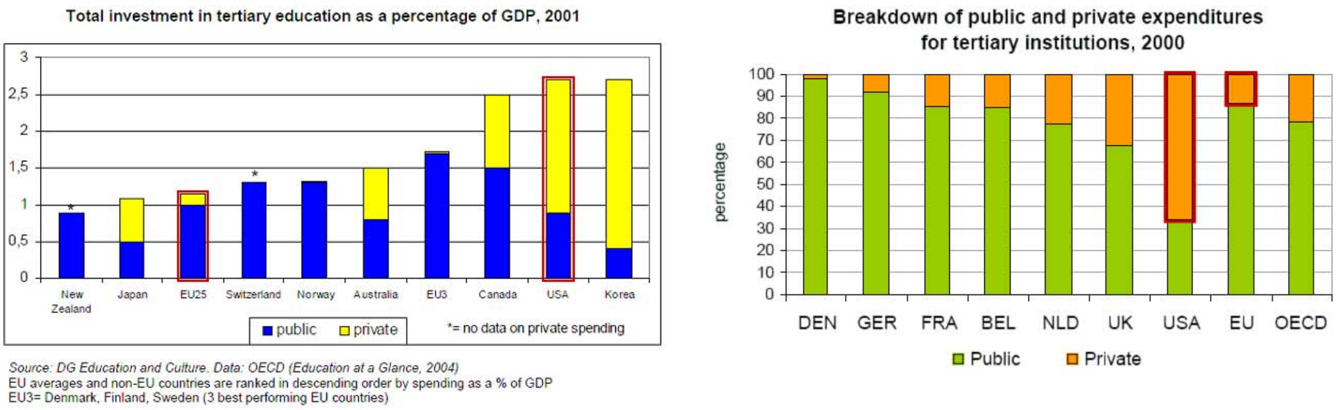
Figs 6 (a, b) Higher Education funding gap between EU25, USA and selected countries, EU25 competency to research potential by comparison to USA and other high ranking selected countries.

One of the Commission's policy recommendations to Member States encourages the use of the EU's financial instruments to develop their knowledge sector. It recommends that Structural Funds be used, via sectoral operational programs dedicated to the development of human resources, research and innovation. This would help boost the modernization of the higher education sector. The Communication emphasizes that this potential source of university funding has gone underused up to now. Nevertheless, the EU10 faces major challenges in realizing this ambition and maintaining research activity of such magnitude, whilst bound to a system of research grossly depended on public funding, in contrast to a system basing its robustness and success on the ample industrial subsidization ***(Figs 7 a,b,c and 8 a,b).***

The EU produces more maths, science and technology graduates than the USA, but has to seriously compensate for higher unemployment ratios along with the fact that has fewer researchers in the labour market ***(Fig 8)***. This particular capacity offered in the American domain for nearly double employment of researchers w.r.t. EU, has been largely responsible for the subsequent "brain drain" of researchers from Europe, out of which less than 20% eventually return to their origin.



Figs 6 (a, b, c) EU governmental based funding for R&D as compared to USA equivalent, gross domestic R&D comparisons for selected countries, USA R&D by source of funds and importance of industrial role



Figs 7 (a, b) Total investment in tertiary education as a proportion of public and private funding for various countries and comparison between EU25 and USA, percentage estimations of indexes.

Production & Employment of Researchers in 2003

		EU 25	USA	Japan
New PhDs	All disciplines	88 100	46 000	14 500
	Maths, Science and Technology	37 000	16 200	5 500
Employment of researchers (FTE)	Total number	1 167 000	1 335 000	675 000
	Researchers per 1000 persons in Labour Force	5,5	9,1	10,1

Source: EUROSTAT and OECD

Fig. 8 Production and employment of researchers comparison between EU25, USA and Japan

Europe will be unable to maintain its supremacy in PhdS performance for long, without a radical restoration of R&D funding to a competent level of 3% by 2010. There are several question to consider on the methods that can achieve that, as well as the potential compromises that may be hidden in the eventual methods employed. Simply put, the industrial participation in achieving target funding, also embounds a high level of quality control, monitoring, and accreditation of results. Accreditation consensus and top institutional competency, has been a troublesome issue in Europe, often amplified by using its cultural diversity as an obstacle. The performance of many EU universities was only moderate and sometimes downright poor, increasingly more so under the extended Europe. Dearth of infrastructure and unevenness of offered facilities, contribute to abstractive rather than competent research –a true penalty for the engineering discipline. Research largely takes place in universities; and the best way of of leveraging and commercializing under the current status, would be to attract strong business links to university research. However, policy issues and disparities across European nations and institutions, do not allow for the flexibility required for structural institutional reform, making such cooperation schemes unattractive –if at all possible.
The European labour market cannot function effectively and smoothly without a **European framework** to stand as a **common reference** for the **recognition of qualifications**. It is a matter which has also significant implications for every member of society and society itself: equal opportunities on the European labour market and the development of European citizenship also depend on the extent to which the people of Europe will really be able to have their diplomas and certificates recognized everywhere in the European Union.

Several instruments have been invoked since EU's Lisbon Strategy, as the "Education & Training 2010" target : to become a reference for quality/relevance, to create a sufficient level of compatibility, to become preferred choice of mobile talent. Research, along with 3% of GDP spending on R&D by 2010. Several fortifying policies have been also applied so far with arguable success, like: "the European way" -virtual or physical centers of excellence, project driven NoE (Networks of Excellence), selective investments in infrastructure, science parks to knowledge cities, investments in mobility, investment in joint degrees. However, it is important to also discern that applicable research, is quite different than abstractive research – or research that merely improves the status of participating experts. Some trends, have a proven value, like the development of European exchanges. This can be explained by the considerable success of the European university exchange programs, starting at the end of the 1980s. Admittedly, the target of 10% of students visiting another country for a period of a semester at least has never been achieved. At the start, such exchanges did not affect students in all disciplines equally. Foreign language students were the first to benefit from exchanges under the interuniversity cooperation programs (ICPs) of the EU Erasmus and Lingua programs. However, business administration and engineering courses were rapidly able to integrate exchanges into their study programs, and so make study visits abroad more attractive. The funding provided by the European Commission and by the French Government tailed off as the programs became more successful. The territorial authorities, and in particular the regions, were called upon to make up this funding in order to enable students to meet the extra cost of studying abroad. The replacement of the Erasmus programs by a broader program, Socrates, has brought about a change in the rules, laying down the principle that national governments must gradually take over Community funding. The reduction in funding for promoting student mobility is a matter of concern for those in charge of international exchanges. Even then, a radically improved scheme that would entail a very high degree of student mobility –above 50%- and part time participation in industrial or academic technology projects, appears to be a dream for EU. A viable alternative is perhaps, a way to enable the capacity for such cooperation, without the actual cost of mobility.

2.4. Honouring the Gender Equity, may also unleash a high hidden potential

The 21st century society will have to prove its maturity in several respects regarding societal status –primarily fairing the gender equity issue. Progress in this social trench will probably encounter more arduous situations at the very edge of social forbearance –and even religious fundamentalism, after the forthcoming "enrichment" in the cultural plurality of the extended European domain. European policies for gender equity, have deservedly followed the women's rights movement that first discernibly arose in Europe in the late 18th century, leading to the consequence that the percentage of women employed in wage labour significantly developed. However, despite the fact that divisions between the gender roles have been shifting rapidly –particularly since after 1970s, very much still exist. Genders tend to excel only in the areas of study traditionally attributed to their sex, and this may partly explain male dominance in many fields such as science and engineering. However, what has been stereotypical missed even by the western culture, is provision of an effective mechanism to prove the actual extend that sex-associated behaviour, such as male aggression and female passivity, is derived -at least partly- from roles which are taught during childhood. That observation still remains a fundamental issue prior to developing a fair and well tuned educational and employment system of equal opportunity. On the other hand, it could also reveal the potential impact that education holds as a fundamental determinant for our societies.

As can be seen for the EU ***(Fig. 9),*** women's participation in the employment opportunity is still seriously lagging, particularly in the engineering and construction areas, with financial and business sectors following. The deepest significance in these long-proven trends, should not be sought in either the lack of EU decretory efficiency or to the natural gender differences in competence, but rather to a complex breed of these issues, along with the necessity for a new competency development system. However, the EU employment target for women set for 60 % in 2010, does not seem to realize this constrain.

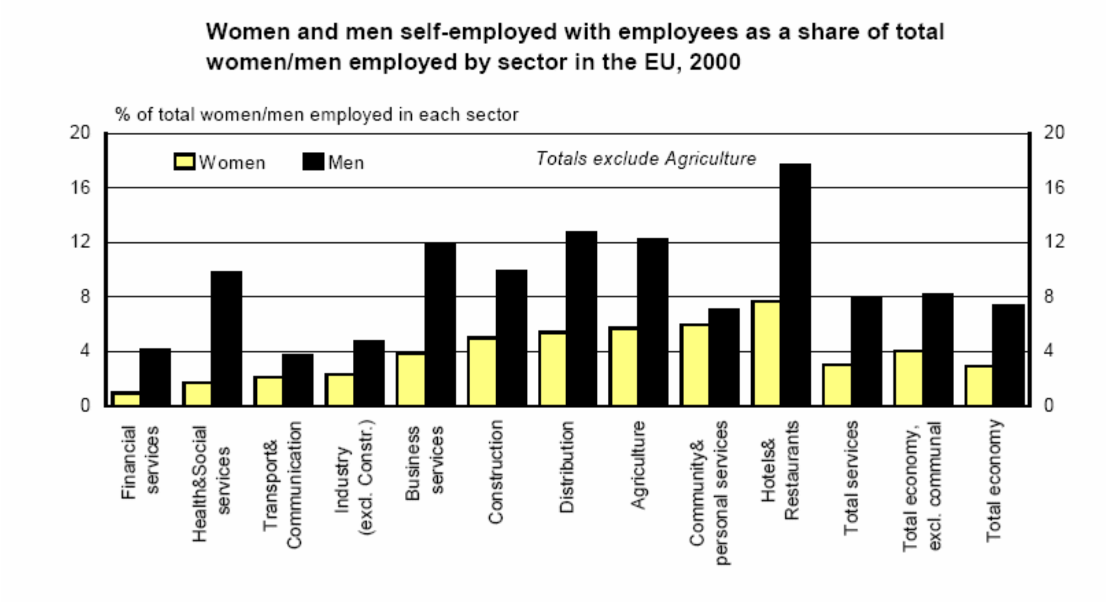
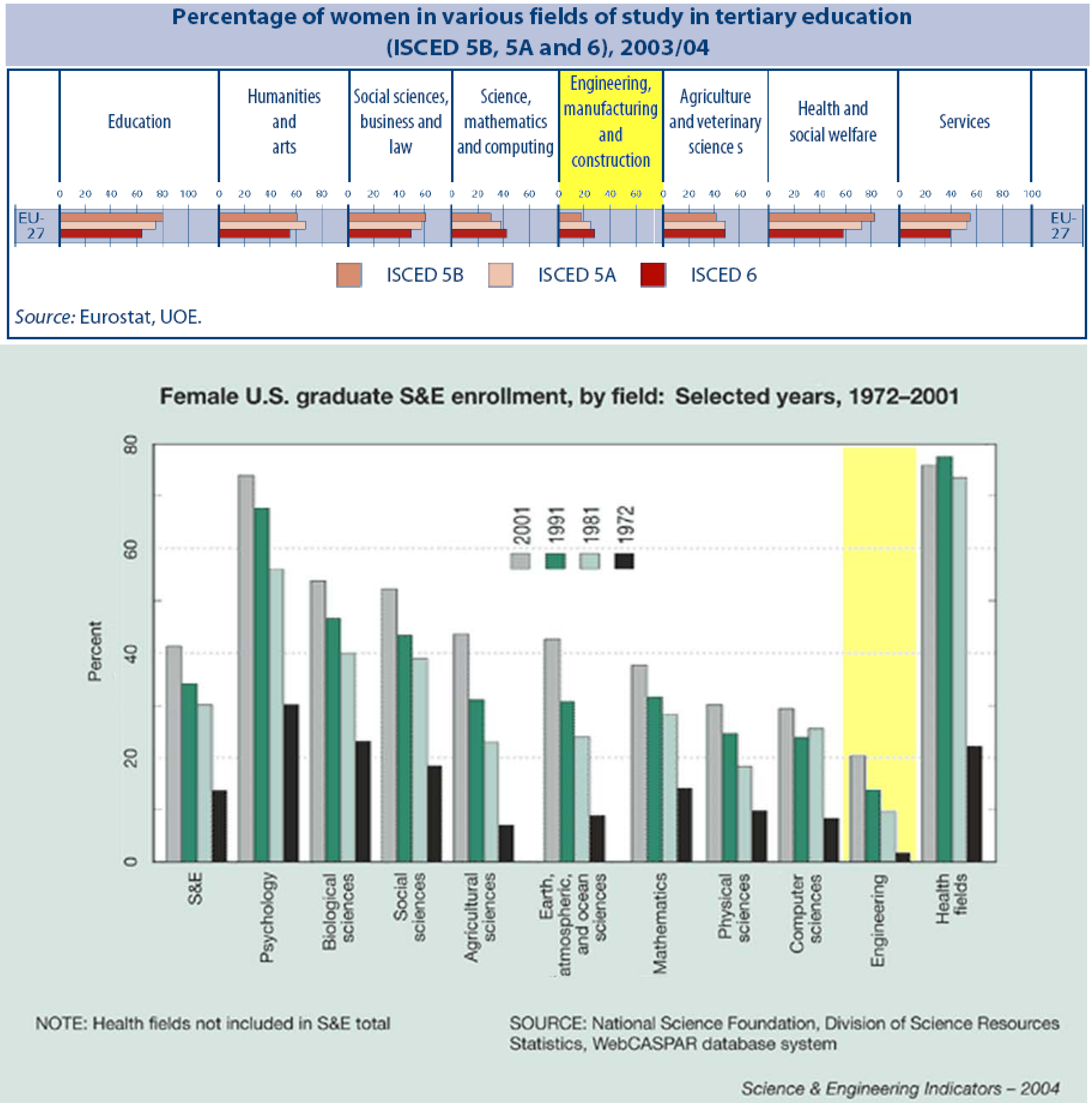


Fig. 9 Women's participation in EU economy structure by sector

With particular respect to the engineering career sector, it is evident that women participation is very low in both EU and USA domains, with a notable improvement over time, along with a higher presence in higher educational layers of the field. ***(Figs 10 a, b).***



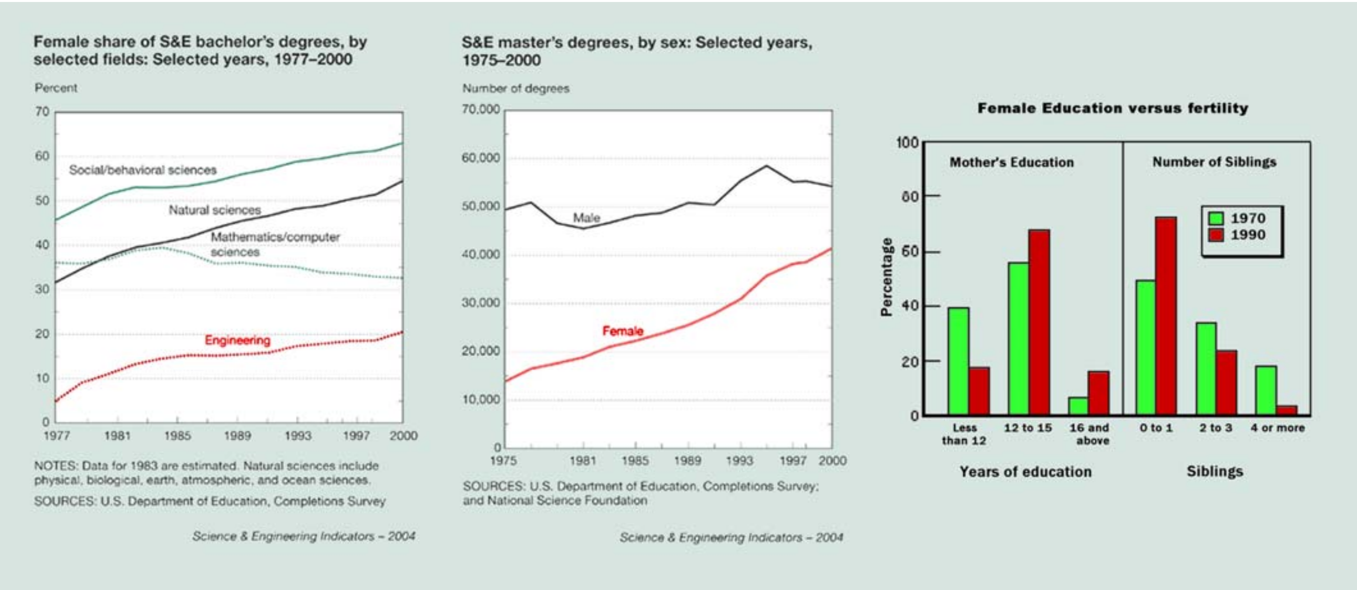
Figs 10 (a, b) Percentage of women in engineering fields of tertiary education in EU, USA percentage of female S&E graduates enrolment in engineering.

Further on, although in some fields such as science, mathematics, computing and engineering, manufacturing and construction, men remain in the majority, the opposite occurs in the humanities and arts, education, and health and welfare (Euridice 2007).

Under these speculations, the serious variation of women's participation in technology careers as well as their low percentage in the senior teaching profession among EU nations, with no apparent deficiency in High skill capabilities, should rather be attributed to social and decretory issues of a non directly discernible nature. On the other hand, the serious scarcity in female participation related to more labour-intensive low level of skill –engineering in particular, reveals that there is a true natural barrier in the type of labour candidature among sexes as well. Hence, design of an ambitious and forward looking educational, career and employment scheme, favoring gender equity to its maximum potential, cannot be based on equity and provision of equal opportunity alone; instead it will have to take wise steps as to safeguard equity whilst still protecting and respecting gender individual differences in competency and social attitude.

A further infallible indicator of the social trend regarding women's competency improvement, appears in the correlation between career and fertility rate ***(Fig. 11 c)***; the dramatic fertility reduction is a clear sign of a phenomenon with opposing dynamics to advancing women's competency, which is advancing in relation to academic career development in S&E ***(Figs 11 a, b)***. The key point to denote here, is that mere adoption of protectionism initiatives in national or EU levels (advanced motherhood benefits, social security policies, decretory legislation, etc.) would not offer a sustainable or stable resolution to this problem.

The enabling follow up should be rather sought to the redesign of a life-through learning and competency improvement system, that may allow exploitation of personal engagement in more flexible ways. The potential and benefit from gender specific benefits and sustainable strategies for engineering career, may offset several of the problems apparent as both in engineering profession scarcity, as well as in the area of engineering educators. Coming technological trends, which are as yet unexplored (i.e. the building automation and energy management services) could reveal a wealth of new electronic services in the engineering domain. Although traditionally a field-proven profession, the engineering arena becomes rapidly enriched with a wealth of peripheral applications and supporting services. This is one of the potential areas where competency, career and family, could optimally combine. The key issue to denote, is that a robust model for delivering a public software infrastructure, able to support a perpetual cycle of employment (in the form of services or otherwise), life-long learning, and, career rehabilitation, should become a development priority.



Figs. 11 (a, b, c) Ascending share of female S&E engineering bachelor's degree, ascending share of female S&E master's degree. 1975-200. Female education versus fertility evolution chart and demographics of fertility evolution in EU.

2.5. Engineering as a social aspiration and career endeavour

Probably the most elusive aspect to assess in this paper, are the intrinsic parameters that govern aspiration and social fulfillment, through an engineering career. The magnitude of the issue assessed, may be of grossly larger proportions than what originally expected, and it has come into perspective during the last 15 years. A complex issue as to contain into a statistical analysis, obeys highly qualitative terms that are intensified in developed societies. The selected subject for such qualitative analysis in this case, is Norway, as enfolding to a nearly ideal environment for educational policies evolution.

Norway ranks the first of the world in terms of aggregated living conditions as measured by the Human Development Index of the United Nations (UNDP, 2006). Being a welfare state, GDP per capita and living standards are high by international comparison. Wealth is relatively equally distributed in this country, through a 'Robin hood' style taxation system. There is no extreme poverty and only a very small number of people are living in relative poverty in Norway. The country enjoys the lowest unemployment rate of the labor force between ages 16 to 74 and in addition, the rate decreased from 4.9 per cent in 1995 to 4.6 per cent in 2005 (Statistic Norway, 2006). Moreover, the unemployment rate is around 17 per cent for Norwegian young people who enter labor market at age 16 to 19 without a upper secondary education certificate and 9 per cent for the ones who are in labor market between age 20 and 24 with an upper secondary diploma.

Upon entry into upper secondary schools, students make a choice between the general education path which leads to university entrance and a professional education path lading to certain vocational competences in the labor market or further vocational training at tertiary level. Although their life time incomes do not differ much among the Norwegian young people who pursue different education paths, their career choices at the entrance of upper secondary school do lead them into different occupational sectors, in which certain class cultures have developed to distinguish them from each other in the society.

Using data from a national questionnaire survey conducted in secondary schools in Norway in 2002, an attempt will be made to highlight the pattern of values in student career aspirations. The monitored portfolio, encompasses a wide spectrum of aspiration-forming parameters, including parental education, occupation, the intensity of parents' educational pressure, stress or encouragement and family size, factors such as gender, ethnicity, types of institution, college environment, student's study major, along with cost and financing methods consideration, are among determinants found to have impact on student career aspirations.

Exactly 12,000 students were randomly selected from 73 lower and upper secondary schools to answer the questionnaire and the response rate was 92.3 per cent. Among the respondents, 5,564 were in upper secondary schools and 52 per cent of them are female. Furthermore, the data showed that only 35 per cent of the students in vocational path actually plan to pursue tertiary education while 17 per cent of the ones in general path do not plan to go beyond upper secondary level. Eventually, while over half of the male students do not plan for tertiary education, 66 per cent of the female students plan to do so, which is a very important finding by itself, as verifying previous chapter deductions about the latent potential in female careers.

The results are presented in ***Fig. 12*** and are quite revealing on an issues suspected, as forging a new layer of considerations for career related issues, as well as about the overall success of the engineering profession to imbibe social endeavors and inspire the youth. Hence, the results, besides the expected high scores complying to standard expectations about financial compensation and career safety, they expose a very high intrinsic value related to deploring the personal creativity potential, as well as a high esteem attributed to social accolade.

As per actual significance of these results, it was found that 18 per cent of the upper secondary school students in Norway are in engineering related vocational paths. Among them, 12 per cent are female. The interesting thing is that many of the upper secondary school students who are in engineer related vocational training courses are not aspired to work as engineer in the future. In fact, only around **15 per cent of the students in engineering** related vocational training actually think of working as engineers in the future as shown in ***Fig. 13***.

The Most important considerations and preferences for a future job

Category/ Value orientation	Response items	Mean score	s.d.
1. Utility/ Money, status	Jobs that give prestige and high status	3.0	1.1
	Jobs that give good salary	**3.9**	0.9
	Jobs that give good possibilities to become leaders	2.9	1.2
2. Intrinsic/ attainment	Jobs that allows me using my own special talent	**4.1**	0.8
	Jobs that allow me using my fantasy and creativity	3.5	1.2
	Jobs that are creative and idea-rich	**3.7**	1.0
3. Social/ humanity	Jobs that are socially meaningful	3.2	1.0
	Jobs that I can do something for the others	**3.6**	1.1
	Jobs that I can work with people	**3.6**	1.2
4. Safe/ security	Jobs that do not have much difficult things to learn	2.6	1.0
	Jobs that I can have a lot free time	3.2	0.9
	Jobs that are not too stressful	3.4	1.0
	Jobs that are least possible to become unemployed	**4.1**	0.9

SOURCES: STUDENT CAREER ASPIRATIONS IN NORWEGIAN UPPER SECONDARY SCHOOLS **Lihong Huang,** NOVA – Norwegian Social Research, 2002

Fig. 12 Norwegian secondary level students aspiration and personal value indicators towards career path considerations. 2002. The responses are on 1-5 points Likert scale as '1' denoting 'not important at all' '5' denoting 'very important' and '3' as neutral.

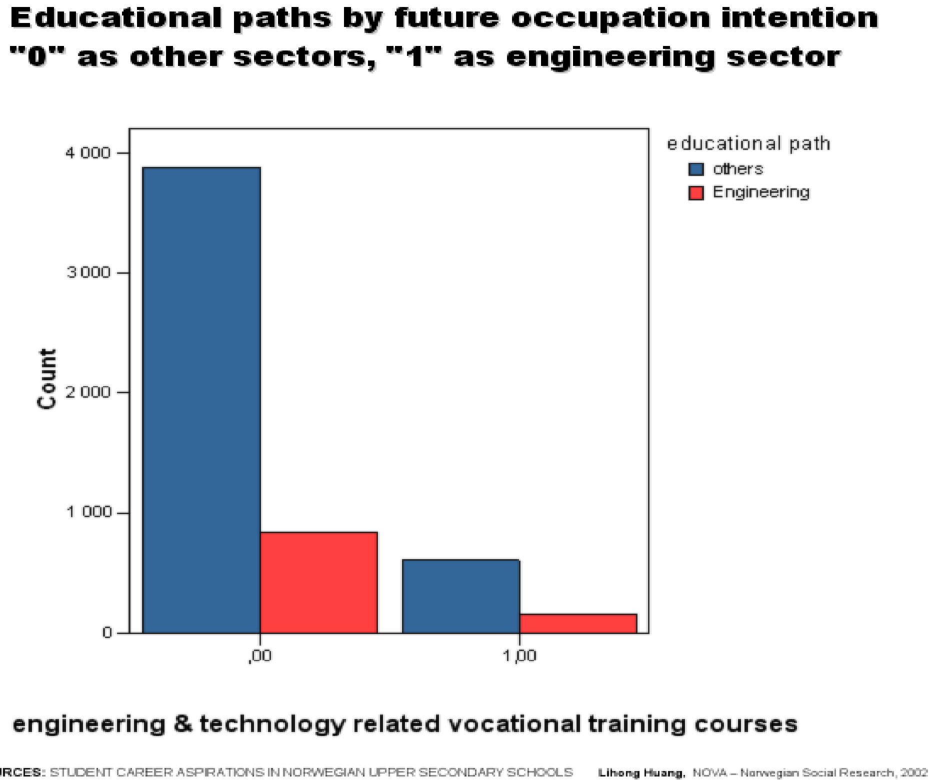


Fig. 13 Norwegian secondary level students in technical vocational training preparatory courses. Chart under '00' shows those intending to pursue engineering career. Chart under '1.00' percentages of those eventually selecting engineering.

Interpretation of these results, should likely result in a radical reconsideration of our approach towards inspiring incentive for engineering to youth, as well as for educating future engineers.

Comparing and verifying these results with longer temporal census data variation (http://www.ssb.no), we can observe that Norway has been lack of engineer for many years. The national data about occupations in the labour force from 2000 to 2006 show very little change of the situation, particularly in the tertiary layer, as demonstrated in ***Fig. 12***.

Engineering Labor and Educational Trends in Norway

Year	2000	2001	2004	2005	2006
total labour force (in 1000)	2269	2278	2276	2289	2354
engineers with long higher education (in1000)	14	16	17	17	15
engineers with short higher education (in1000)	107	120	102	110	119
% of engineers in total labour force	5.3	6.0	5.2	5.5	5.7

SOURCES: STUDENT CAREER ASPIRATIONS IN NORWEGIAN UPPER SECONDARY SCHOOLS **Lihong Huang,** NOVA – Norwegian Social Research, 2002

Fig. 14 Engineering career demographic trends in Norway

The accurate interpretation of the aspiration and urge for personal advocation, talent and creativity advancement, may be a soft issue to assess in future strategies for promoting engineering career, as perhaps it will be a challenging task to prove and highlight a connection of creative expression, with the science and technology disciplines in general.

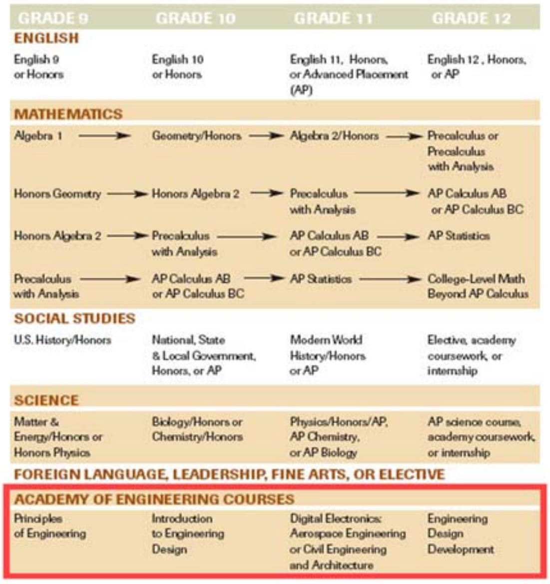
The above postulation must not be misinterpreted in its context and meaning. It is well respected that Creativity is sought everywhere: in the arts, in entertainment, in business, in mathematics, in engineering, in medicine, in the social sciences, in the physical sciences. Common elements in creativity are originality and imagination. Creativity carries feelings of wide ranging freedom to design and to invent and to dream. But in engineering and science, creativity is useful only if it fits into the realities of the physical world, added to the socially imposed rules that it must also be subjected to feasibility and practicality. Simply, a creative idea in science or engineering must conform to our present knowledge of the nature of matter, unless we invent or find a new form of matter. Although a natural consequence to the trained – or the compromised- adult mind, devising a system to promote engineering career aspiration to the youth, must be a feat requiring an assiduous and anticipative planning, commencing from the early youth. Important to denote, Norway, as a selected case example, bears a close case analogy to a situation common to North American societies as well.

2.6. Restoring inspiration towards technology as an educational practice

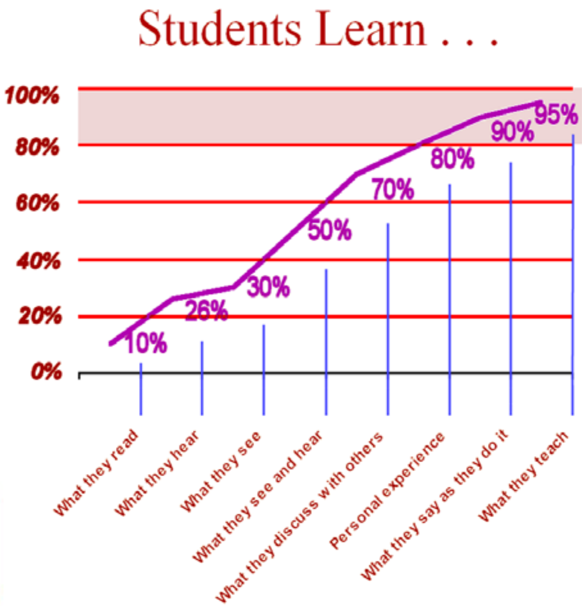
The mere purpose of addressing such an issue in this essay, is for making a point not only in an exemplified practice –which is due to produce results in the right direction, but mainly for complementing it further as to the ancillary actions to support it on the longer term in the personal career.

The case example analyzed in this section will be that of the Wheaton High School in Montgomery County, Md., USA. This is a highly rising in popularity initiative, under the Project Lead the Way program, which is aimed at propelling more U.S. students toward engineering careers is attracting recruits beyond the usual pool of prospective high school talent. Students enrolled can choose from among several sequences of courses designed to prepare them for the postsecondary study of engineering. PLTW was singled out by the congressionally chartered National Academy of Sciences in its oft-cited 2005 report (“Rising Above the Gathering Storm”) which recommended that the program serve as the national model for expansion of science and engineering education.

Figs 15 a, b, depict this Grade 9 - 12 curriculum, along with the known rule that safeguards positive learning performance repercussions to follow.



GRADE 9	GRADE 10	GRADE 11	GRADE 12
ENGLISH			
English 9 or Honors	English 10 or Honors	English 11, Honors, or Advanced Placement (AP)	English 12 , Honors, or AP
MATHEMATICS			
Algebra 1 →	Geometry/Honors →	Algebra 2/Honors →	Precalculus or Precalculus with Analysis
Honors Geometry →	Honors Algebra 2 →	Precalculus with Analysis →	AP Calculus AB or AP Calculus BC
Honors Algebra 2 →	Precalculus with Analysis →	AP Calculus AB or AP Calculus BC →	AP Statistics
Precalculus with Analysis →	AP Calculus AB or AP Calculus BC →	AP Statistics →	College-Level Math Beyond AP Calculus
SOCIAL STUDIES			
U.S. History/Honors	National, State & Local Government, Honors, or AP	Modern World History/Honors or AP	Elective, academy coursework, or internship
SCIENCE			
Matter & Energy/Honors or Honors Physics	Biology/Honors or Chemistry/Honors	Physics/Honors/AP, AP Chemistry, or AP Biology	AP science course, academy coursework, or internship
FOREIGN LANGUAGE, LEADERSHIP, FINE ARTS, OR ELECTIVE			
ACADEMY OF ENGINEERING COURSES			
Principles of Engineering	Introduction to Engineering Design	Digital Electronics: Aerospace Engineering or Civil Engineering and Architecture	Engineering Design Development



Figs. 15 (a, b) Grade 9-12 curriculum enhancement proposed by National Academy of Sciences in USA towards improving skills in engineering education, and correlation to the well known rule for student learning.

Strategic promotion and favoritism of specific educational disciplines, would definitely produce results, but only optimal when complemented with actions for Accelerated Learning.
The well defined model of Richard M. Felder for different *learning styles*—characteristic strengths and preferences in the ways they take in and process information, among students, is a tangible ground of reference used. Some students tend to focus on facts, data, and algorithms; others are more comfortable with theories and mathematical models. Some respond strongly to visual forms of information, like pictures, diagrams, and schematics; others get more from verbal forms —written and spoken explanations. Some prefer to learn actively and interactively; others function more introspectively and individually. Learning style is the way in which each learner begins to concentrate on, process, and retain new and difficult information, which in turn assumes a biologically and developmentally imposed set of personal characteristics that make the same teaching method effective for some students and ineffective for others (Dunn, Beaudry, and Klavas, 1989). Although a description of different categories, or styles, of learners, tersely classified as: Auditory, Visual, Tactile and Social – and in practice an interaction of all styles to a different degree as to boost cognitive performance. The real question is, how our modern information and educational technology infrastructure can offer such an advanced learning environment for practically every student. It is hereby postulated that our publicly and openly available multimedia infrastructure we possess, does not fulfill such an expectation, in both qualitative and level of attainment terms. The crucial point to denote is, that this is possible to be developed, with existing available tools and methods. Nevertheless, should such a benefit become available, in order to apply for both developed and developing societies, a number of issues should be resolved as well. Practical issues, include designing a knowledge for delivery on information networks and infrastructure, of comparatively modest levels, since a majority of latent brain capital is scattered in areas with a high degree of "digital poverty", making it practically impossible to conduct commensurate educational and research cooperation with the infrastructure rich societies. Non obvious -but increasingly prominent- issues, include the exigency for new methods in capturing, preserving and proactively managing individual human knowledge and experience, during the life course, starting even from the early years. If we would name such an imaginary service "personal knowledge acolyte", it is equally important now to define a framework for its development and public adoption.

3. Introduction to the scope and rational of the EUEDOS initiative

Apart from radical leaps in exploitation of technology, education should pursue transition to a stage –a **system of methods** as a more candidate term- **able to manage and espouse change itself**. This very notion has not been exhaustively addressed in European education and, the infusion of technology has not reached further than the realm of **e-Learning**. The e-Learning initiative proposed by the Commission in order to attain the goals set by the Lisbon European Council, is designed to mobilize the education and training communities, along with the economic, social and cultural players concerned, in order to enable Europe to catch up and accelerate the introduction of the knowledge-based society. The e-Learning initiative is based on four main lines of action: multimedia equipment and networking, training at all levels for each teacher and trainer, the development of good quality multimedia services and contents, the development and networking of centers for acquiring knowledge. Although the e-Learning initiative may have defined the main modalities for allowing technological accession in education, there are **several milestones of operational and technological nature** that will **need to be developed** as to enable this, as well as to actually **connect it to a roadmap leading to a commensurate labor reformation**. The engineering discipline is probably the first to become affected by such changes, but this may happen as a reflection of either successful, or unsuccessful policies. The EUEDOS model, attempts to introduce a feasible and easily adoptable framework, for expressly addressing educational problems, at both advanced and less favored national environments. It is derived and shaped from a close introspection to the dynamics and deficiencies of educational and societal evolution, in some particular aspects, such as assessed in chapter 2. However, the basis of its rational, primarily introduces a technology model rather, as the starting point to support aetiology towards steering subsequent adoption of required policies for education and labor reform. This pragmatic approach may rapidly produce unbiased results, with emphasis in science and engineering.

Fig 16 presents the basic relation –i.e. a conceptual "Grid"- of statutory, institutional and social actors involved in the operation and performance of the EUEDOS model.

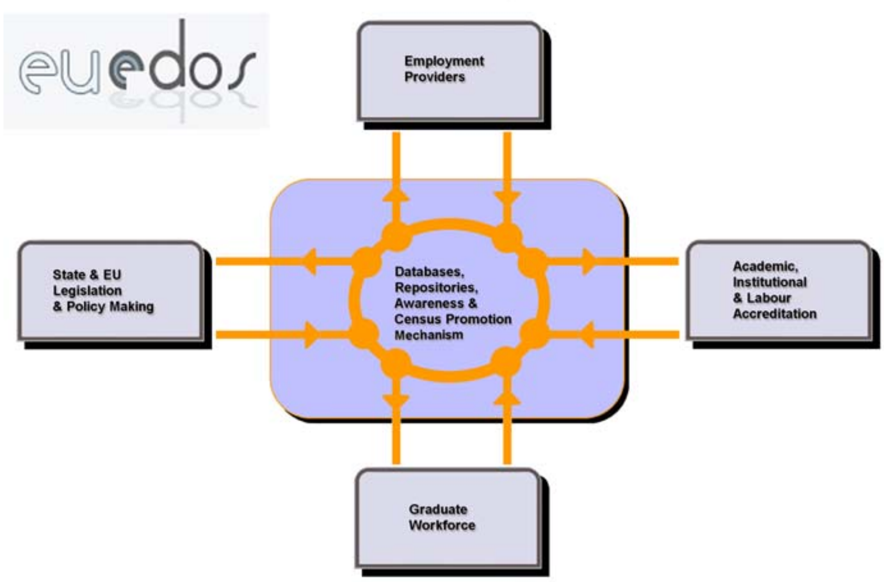


Fig. 16 Conceptual Diagram of the EUEDOS Grid and major actors involved

The major policy cycles endeavoured to be served by EUEDOS are:

- ***sustain awareness and employment dynamics evolution***
- ***maintain active employment promotion and mediation services***
- ***create and motivate towards an interleave opportunity between employment and education***
- ***foster a framework for maintenance and exploitation of the individual's life course knowledge capital and experience.***

3.1. The EUEDOS model basic structure

This preliminary study, introduces an **integral 3-layer roadmap** for implementing an effective and pragmatic delivery, of a technological model able to interleave and render an individual's employment and academic profile, as inter-nested to his/her life-through education. It can be readily applied as a complementary activity to standing policies and institutional structures. A robust technological framework is further introduced able to act as an effective roadmap for Life-Long-Learning activities, as well as sustain the accumulated wealth of the life-through experience assessed by the individual. Effectively, this model is realized as a set of next-generation distributed applications designated as:

a) **Audited databases classification** and maintenance of an individual's integral and dynamic profile of dexterities and qualifications -either academic or vocal- acquired along his/her carrier path, as an intermediate link between industry and academy, as well as provision for automated employment profile correlation and matching services. This is a perpetual promotional service offered by an accredited academic institution to the individual.

b) **Distributed Information Collaborative Repositories** as a mediation and engagement environment for project collaboration and management between industry and graduate or post-graduate academic candidates. This layer will enable a smooth accession from graduate stage to the professional rehabilitation for an individual, whilst also providing an interim financial compensation to all involved actors, i.e. students, institutions, industry, tutors and State.

c) **Thematic Knowledge Depositories** as an accompanying asset to an individual's academic and professional competence capacity. This is the primary infrastructure requirement for delivering an aggregative model of distributed knowledge and distributed services, as the forestep for implementing the virtual enterprise of knowledge workers.

3.2. The EUEDOS career monitoring and employment mediation database system

The envisaged curriculum database environment to implement the service (a) should allow an open structure, configurable environment where formal (accredited) data would be committed by the institution, in addition to externally submitted career assessment evaluations, as well as free career-related curriculum and open personal data that could be maintained by the user himself. A structural "penchant monitoring" service is also required in such an environment, as to retrieve and classify regularly incoming census, statistical and other highly tuned career-related data, at the user's portfolio. The database should also allow a registered service to monitor employment offers by either national, international, private or public vendors, followed by an embedded notification service to the users. A forward looking future service, would generate employment seeking search agents, able to match the user's competence profile to employment providers' databases.

Effectively, such an environment could be divided into **two synergistic entities**, a "vertical" action comprising the assembly of inter-networked databases of the accreditation institutions, and, a "horizontal" action comprising the integration activities of the respective vertical databases -among other concerted actions, into a unifying superset database scheme, offering a publicly accessible facility (***Fig 17***).

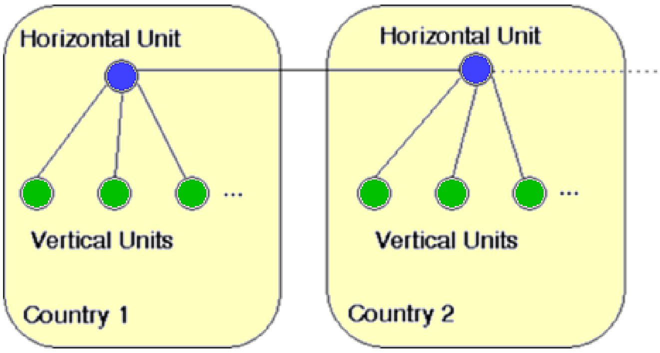


Fig. 17 The basic database model proposed interleaves a synergy between a set of "vertical" institutional databases and a set of "horizontal" -or national databases, acting as an "aggregator" of workforce profiles hosted from the corresponding institutional databases.

The detailed functional and operational relation between "vertical" and "horizontal" activities and databases, is demonstrated bellow in ***Fig 18.***

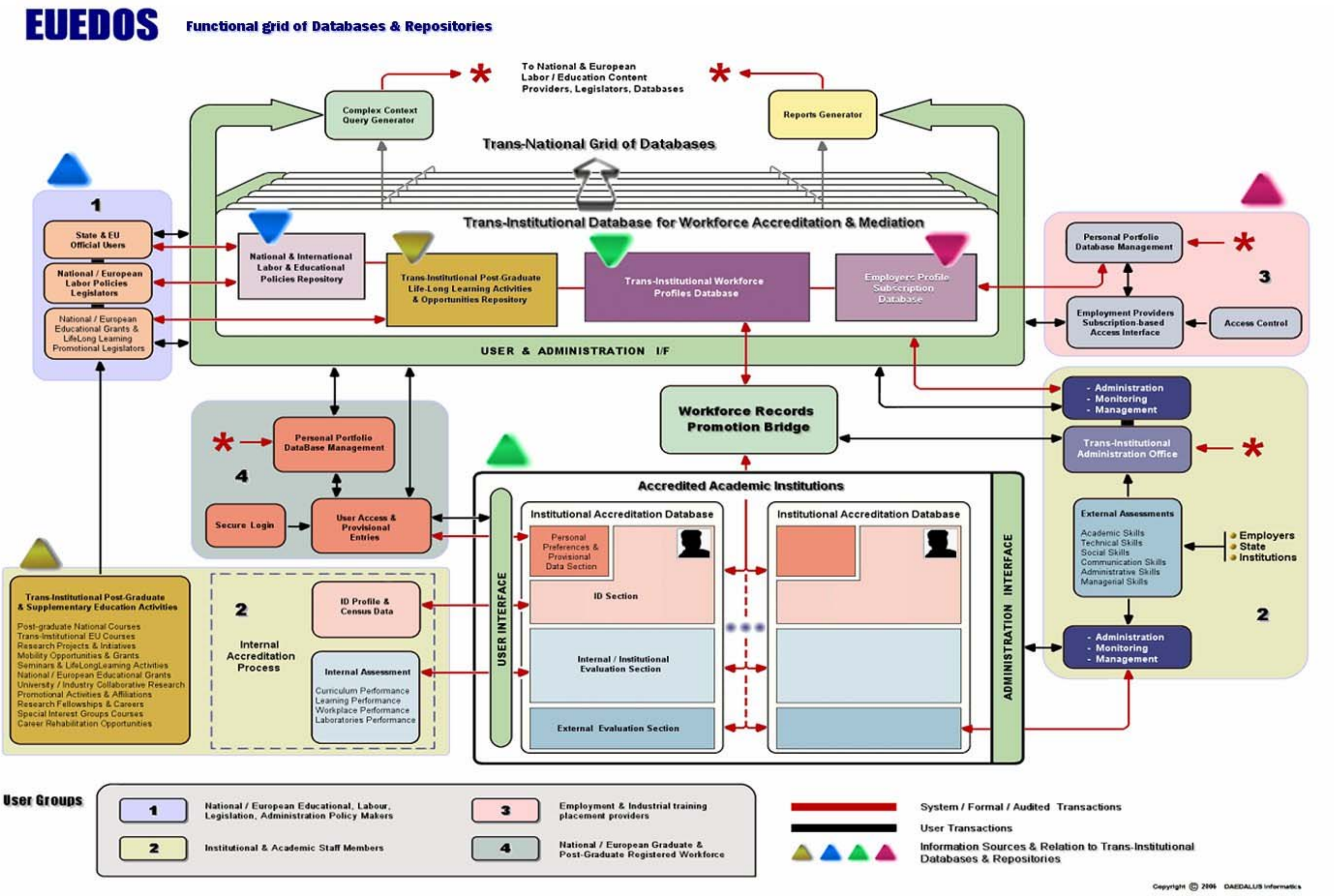


Fig. 18 Operational diagram of the relation between "vertical" and "horizontal" activities in formal institutional accreditation and curriculum registration databases, for promotion of synergy between employment actors in academy and industry

This proposed layer establishes a "perpetual" **relation between an accredited academic certification authority and the individual**, which may apply even through the early years of his academic education. Several benefits are served via this approach, including a cohesive, lifelong link between academy, individual and employment. In this respect, the academic institution (or its appointed proxies, such as CDOs -Career Development Offices) provides a lifelong service to the individual by optimally serving as both, a career monitoring and sustained advisory service, as well as a mediator for candidate industrial placement. The aim is to signify and **establish a distinct roadmap for an ascending "educational ladder" potential** benefit for the individual, where the thread of his/her progress becomes adaptable to his occasional capacity. These educational, **certification/accreditation jurisdictional services** offered by the academic institution(s), are also **complemented** by commensurate **mediation services in employment opportunities**. In this respect, the traditionally rigid relation between supply and demand in conventional labor models, is converted into a highly adaptive process customized as to suit the individual's competency potential. Key principle here is the adjacent placement of services and communal procedural management between career rehabilitation, skill accreditation and lifelong education.

It should be also noted that the environment is fully adept for accepting external accreditation for any particular user record (individual) as well, thereafter recorded and appended to his/her respective curriculum in a vertical database. This facility provides a complete accreditation & registration cycle mechanism, where life through acquired professional dexterities, experience and supplementary academic education, may be officially moderated, rated and promoted to ameliorate employment and career opportunity. Among many side merits, this mechanism also acts as an incentive to the individual, where a tangible motive for developing his profile becomes apparent –implicitly under his private discretion and consent in what is concerning the horizontal activities. This last observation should be emphasized, as a notion of paramount importance for individual rights. In this respect, the offered services are not compulsory to the individual, further than maintaining his minimal institutional record. The choice for the individual to derive obvious benefits from a scalable range of services, is entirely entrusted to the individual's discretion. Nevertheless, the apparent corollary should also apply on fact that, acceptance of a series of formally offered career mediation public services to the individual, should also imply his/her acceptance of a minimum agenda of accreditation for the information –either of private nature or otherwise- that would become available to designated third parties.

The apparent operations include subscription-based services for all operational actors, including graduates (employment seeking), industrial partners (employment provision) and State Servants. Collaborating incentives and interfacing access is also provided for active content (i.e. legislation) providers, and, either private or public jurisdictional authorities, that could regularly update particular sections of monitored public sectors of information. This parallel service is systematized and contextually formatted, prior to availability and circulation to all registered parties of the horizontal activity, on a variety of notification options or rich context formats. In the case of the graduate subscribers -f.e.-, as they are also members in one of the vertical databases, the circulated content could automatically update their personal portfolio section, which is an important feature offered to them as part of their database membership. The subscription mechanism for admission and access to a service, besides formal aspects, will also serve the purposes of detailed audit-trail and logging of activities for all engaged parties, so as to process and offer valuable (anonymous) statistical data and trends, being an essential dynamic service offered by the horizontal action to all subscribers. In all, an open environment for **life-through promotion of an individual's full accredited curriculum** is proposed, designed for implementation as a full on-line, browser accessed service, implemented under the JAVA language. The candidate database engine used for this highly distributed application, could now be a publicly available open source environment, such as MySQL.

The selection for an inherently open and operating system independent environment, further fortifies the scope and span of the applications, making it also an ideal environment for direct internal support by academic institutions. Further to being a fully feasible application, the proposed endeavour may readily combine with existing institutional structure and legislation. Although it is beyond scope of this report to comment on the legislation framework required to endorse this **inter-institutional service**, it is -nevertheless- stressed that the apparent necessity to maintain it as a public service and benefit supported by the State, should not become negotiable.

Fig. 19, further demonstrates the basic flow diagram of this synergistic relation between vertical and horizontal activities, between institutional accreditation and curriculum registration databases, as well as the major trend policies that are eventually served by the long term operation of this model.

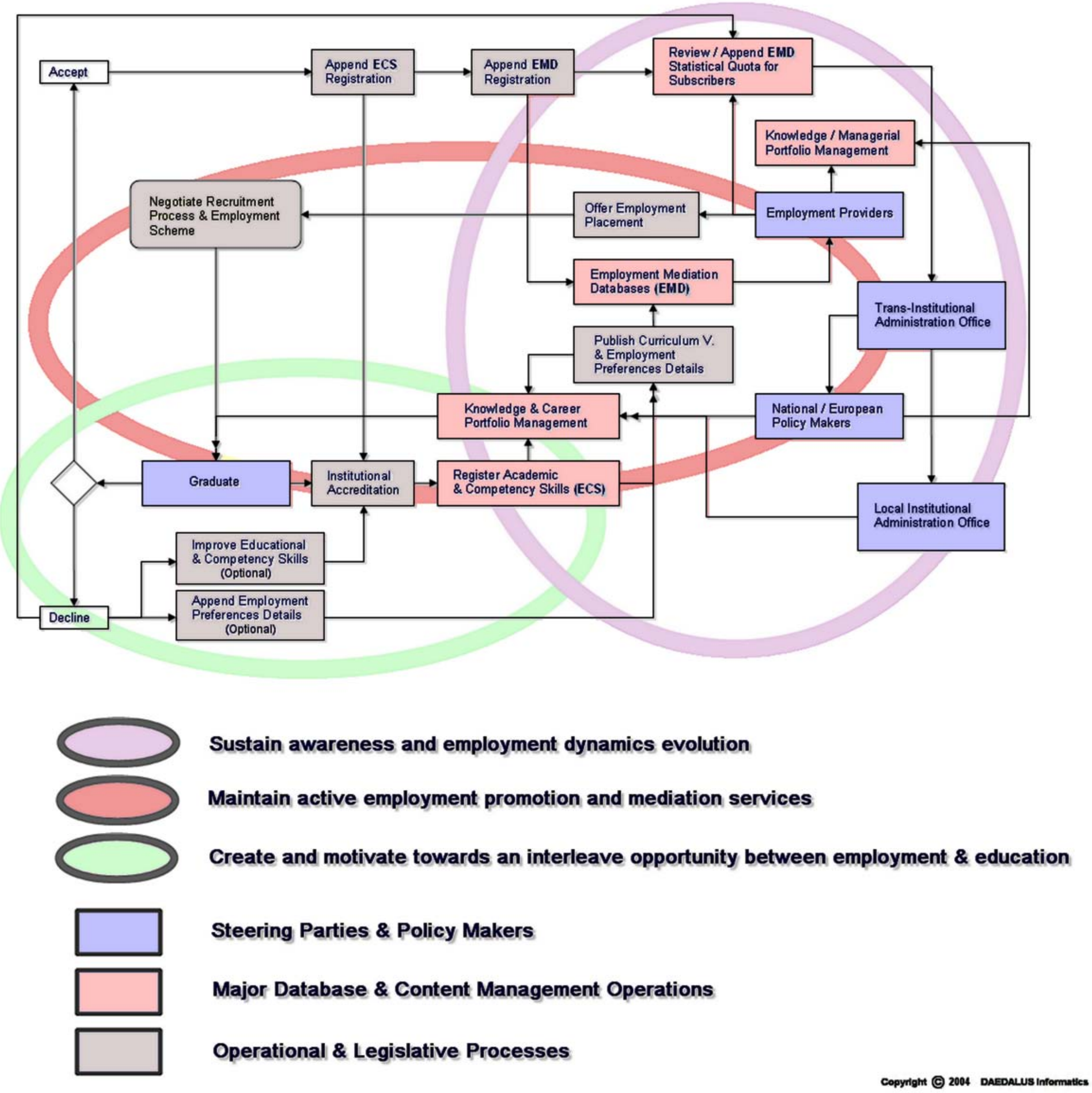


Fig. 19 Flow diagram of the relation between vertical and horizontal activities in formal institutional accreditation and curriculum registration databases, along with major policy cycles served

3.3. The EUEDOS Distributed Information Collaborative Repositories

A key point in bridging the temerarious **gap between an individual's graduate and industrial competence**, is the establishment of a multi-purpose mechanism for mediated task assessment, monitoring and accreditation by both major collaborating adjudicators, i.e. industry and academy. Several pertaining issues are also apparent, as is the necessity for an objective and pragmatic evaluation of the individual's composite skills and competencies, as well as other important social and personal merits. A viable common denominator for meeting all above criteria as well as offering an intensive and sustainable link of collaboration between academy and industry, may be realized as being a **dynamic project management framework**, whereat the reference ground for all attending parties would become a tangible asset of achievement, in the form of a project. The "token" value required as to render this process accountable, auditable and redeemable, is realized in the form of the "document", in turn being a composite assembly of information (token) delivered from the trainees to the monitoring academic and industrial tutoring parties, as to accomplish the given project within a certain time. The monitoring authorities may also serve a specific role of accreditation, delivering a joint evaluation.

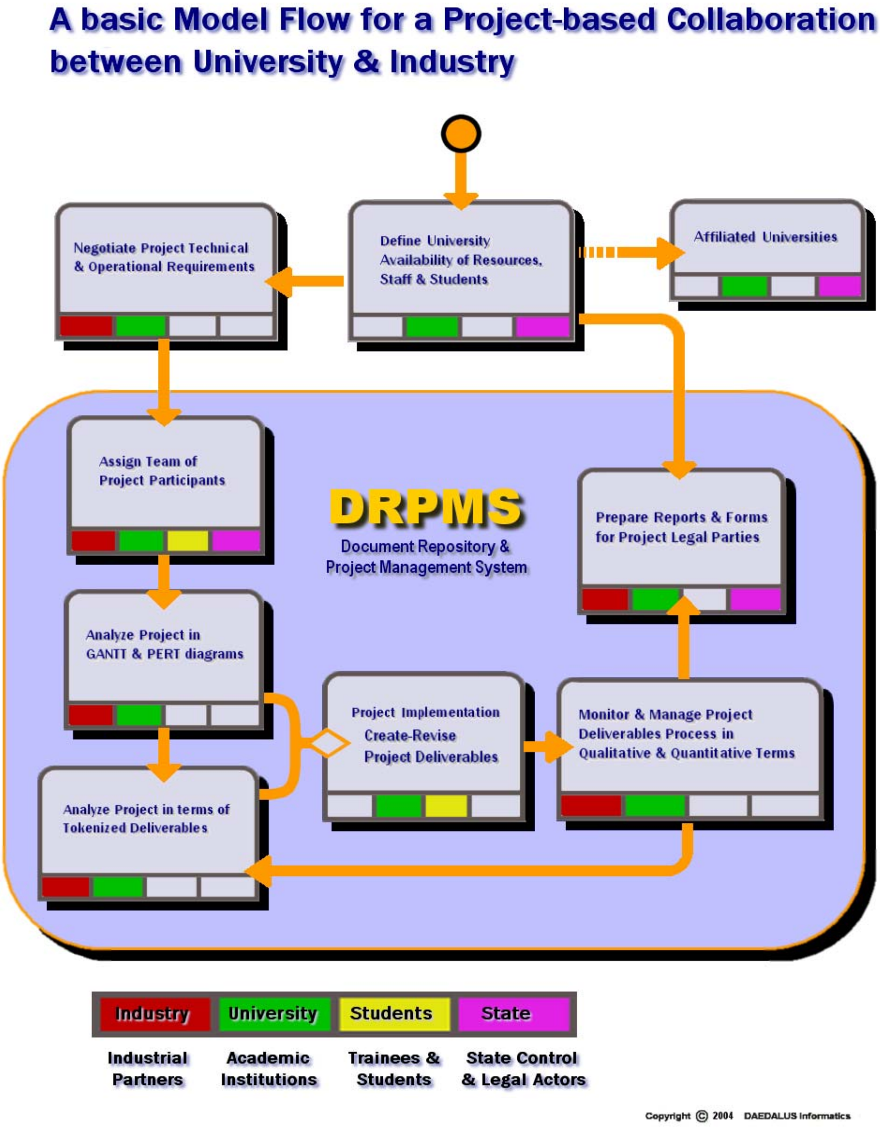


Fig. 20 Layout and principal functional modules and role of participating actors of a Document Administration and Repository Server, as the on-line infrastructure for a Project based collaboration between University & Industry

The above diagram ***(Fig 20)*** presents the basic functionality and role of participants in such an environment, where a cycle starting from declaration of the academic institution resources, fields of expertise and competence, as well as the active academic force (tutors and graduates), are engaged into the full process layout required for analysis, design, monitoring and progressive implementation, of a knowledge intensive project to the mandate of industrial partner(s). The potential role for the principal legal and operational entities in such an envisaged cycle, namely Industry, University, Students and State, is also depicted. Apparently, other categories of formal actors may also participate under the same environment, by merely designating their role in project management, administration and delivery process.

A multitude of University/Industry/Enterprise engagement targets is accommodated via Audited Repositories with Project Management Integration, with most common to:

- Establish a mechanism for enabling the Academic Institution to promote expertise, facilities and research workforce (academics, students, experts)
- Enable the formal and facile collaboration between Institutions & Enterprise
- Promote a trans-institutional, project targeted cooperation, which could eventually develop in concerted commonwealth research actions
- Provide a clear roadmap for breeding innovation leagues between academy and industry, as well as between individuals
- Define a seamless and sustainable accession from graduation to professional competency
- Facilitate a clear and convenient method for bridging the gap of acquaintance and trust between graduation and employability
- Assist the micro and the SME enterprise ascend from the innovation phase to the prototyping phase
- Offer the opportunity to the small enterprise to ascend to the pre-industrial maturity stage, prior to venture capital seeking, whilst offering student training at the same time
- Highlight the roadmap for Academia to evolve, guided by realistic considerations of the LLL, enterpreneurhip, and social dynamics

Several longer term aspects on graduate career enhancement are also targeted as a broader benefit –as is the acquaintance with entrepreneurship. The value of entrepreneurship is heavily neglected for engineering disciplines. The accuracy of this picture is confirmed – at least for 2002 – by the Enterprise Directorate- General's conclusion that:
'Entrepreneurship teaching at the tertiary level currently concentrates mostly on students following economics and business courses, while the offer is still very limited for those studying different subjects, such as sciences, engineering, arts, etc.'

For University research staff and educators alike, a similar opportunity may become readily available as to:
• Craft a proven teaching agenda that includes continual evaluations of the tools and skills educators need towards supporting universities towards 21st century learning.
• Foster an overall commitment to ensure that all levels of educators are prepared to employ 21st century teaching and assessment strategies in their field of expertise.
• Create a research plan for charting the best practices for teaching and assessing 21st century skills; collaborate in researching and developing authentic new assessments for graduates.
• Invest in infrastructure that will make it possible for institutional faculties and educators to acquire 21st century skills.
• Form collaborative work groups with local enterprise and industry and the state to support 21st century research & learning.
• Timely define the 21st century skills needed by freshmen, who are entering engineering or other S&E courses.

R&D innovation-enabling spending can not go on for long for Europe, as a governmental subsidization. This will inevitably affect University research as a collapse in innovation. The solution would be a reformation of the Universities constitution as to allow a direct negotiation and participation with industry, and in particular, joint participation with the SME industry –the European traditional innovation carrier- as to cooperate in generation of advanced technology projects, targeting in sustainability promotion rather that mere innovation. The proposed collaborative project management model/environment, can substitute –to a certain degree- the valuable experience gained by prospective engineers upon their practical experience placement, along with other favourable mobility schemes (ERASMUS. TEMPUS), as concluded in chapter 2.3. It does also hold the capacity, to expand this benefit to virtually all graduates and postgraduate participants, and engage them into an edifying and closely monitored cooperation with industry and real-life application –a vital overall experience for their career, without the high costs inherent to mobility. It does also mitigate the "death valley" gap between graduation and field experience, responsible for a large percentage of early career unemployment.

Finally, the detail related to inter-Institutional collaboration dimension over a specific project, is also served via this module, either or an ad hoc, per project, or commonwealth basis. A motive –facilitated by the project management module- is given as per the capacity of any institution to virtually aggregate resources with an affiliated institution, towards any specified project management target.

3.4. The EUEDOS Thematic Knowledge Depositories

The dawn of the knowledge era will require a major shift in the modalities and methods via which **education and labor** are implemented into society. They will both be **subjected to perpetual change** and they will interleave to a mutually supporting and beneficial, **motive-driven relation**. Technological challenges will focus on delivering great amounts of knowledge context to the individual, at the most dense cognitive rate. The **acceleration of the educational rate** will become a major social issue of the 21st century, in turn posing a high stake to multimedia rendering technologies. This anticipated boost to the individual's learning capacity, will require a **"natural frequency" centric approach** that may only be achieved by targeting his/her achievement-driven motives. This, in turn, could emerge through an option provision for a "tuned" core learning subject selection –an apparently different choice for each individual. This proposition, highly deviates from the currently adopted communal and group-centric public education models. It also introduces a radically new approach in education, as it implies an **asynchronous pace of learning**, suited to the individual's capacity rather than to a group's average capacity. This methodology is also aligned with the actual practice the individual will eventually follow at his professional career, offering the benefit of escaping from the harmful transition experience upon leaving academic life. This feat may prove the crucial importance of technology in future education, as it may only be substantiated and realized as a pioneering vault in information technologies.

The endeavoured software environment to host this layer of implementation, should ideally act as an extension to the individual's arsenal of competences as well as a supporting infrastructure to his personal know how. A key innovation principle to be introduced here, is the requirement from such an advanced personal "**knowledge depository**" environment to host not only assimilated **knowledge** structures, but **expertise** clusters as well, being possibly defined as ontologies of procedural steps for unattended execution of specific tasks on demand. The variable degree of consistency, commercial value and compliance of such expertise clusters towards definite task(s), could render their candidature as either local (personal) or distributable (group or network) tools, subjected to variable grades of commercialisation, presenting a new model for product/service propagation in the software industry. Forward looking anticipated services for such a "**knowledge acolyte**" environment, would be advanced networking and federation features as to enable collaborative distributed knowledge environments to be dynamically created, thus laying a true roadmap towards the information society. A new realm in our social and political manifestation may become eventually possible, if the **enterprise of the 21st century**, becomes the very **individual himself**. The existence of such an infrastructure would progressively lead to the resolution of terms and requirements (legal, operational, financial, etc.) for a commercial system akin to the "commoditization" of knowledge –be that in the form of services or otherwise. In a simplified approach, it could be argued that designing for a computerized system able to manage and access human knowledge as a commodity asset, (as to narrow the imposing philosophical burden of perplexed terms), may be shown to obey a viable set of guidelines –even today. For the purpose of this report we could contain the essential prerequisites in three main categories, namely:

- a framework for promoting knowledge acquisition, management, integration, and innovation generation
- a knowledge promotion and rendering environment as to interleave relation with forthcoming business and employment models, or services
- an advanced environment for capturing and enhancing human experience
- a network of depositories, with seamless networking and grid integration into larger thematic clusters

The starting framework for developing and rendering such a software infrastructure, would be a highly synergistic grid of tools/applications, delivered as "rich Web" application in their entirety, as to offer a virtual and ubiquitous environment of engagement for their users. The governing hosting environment and interface for rendering and control of the peripheral applications, is an advanced Repository environment. The assembly of these applications, is depicted in ***Fig.21***

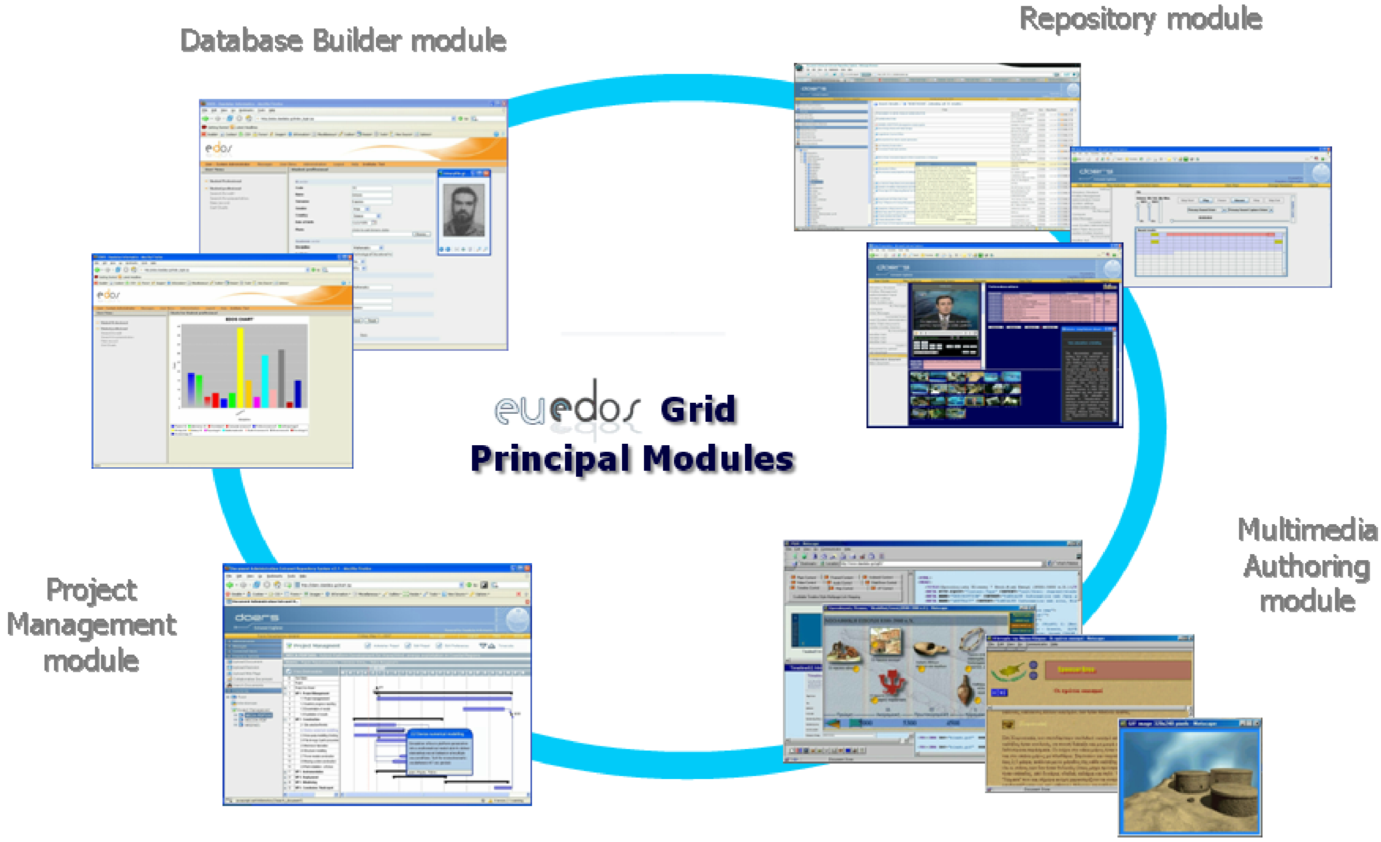


Fig. 21 EUEDOS Grid Principal Modules and Synergy in Collaborative Research Environment

Continued education is underdeveloped in many countries, several EU countries included as well. It should be optimally be incorporated into a future thematic network for all three groups concerned here: students; staff; and professionals. A thematic network for engineering and S&E should be established with the ultimate purpose of acting as a central body, the different sections of which should be involved in developing solutions at international problems.

3.5. The basic design philosophy and operational details of the EUEDOS Thematic Knowledge Depositories

Arguably, the cardinal issue to consider in designing the EUEDOS Repository is robustness and persistence to change and evolution of technology, since it would pause an impossible task to maintain, evolve and migrate a progressively increasing amount of datasets and complex data schemes, compository documents and multimedia data, shared among heterogeneous groups of experts, systems and networks, along pace of time. Full on-line availability of data and methods (applications) is a highly desirable feature, which in turn implies a browser-centric rendering of the entire User Interface. Although some abstraction and virtualization to the repository resource should benefit from this approach, a high level of added difficulty is also added to the overall development effort. A longer vision should also pertain as to the technological considerations that adhere to cost of operational infrastructure, cost of maintenance, cost of administration (directly coupled to complexity and spread of infrastructure required), as well as forward-looking trends, as is the eventual potential of reverting the environment to Open Source benefits for support and customization.

The diversity and complexity of the information entities cycle management and rendering under EUEDOS, can be easily appreciated by the fact that it comprises dense research as well as applicable activities from a multi-disciplinary spectrum of fields. Managing to sustain an e-Research network under such a spectrum of requirements, would clearly necessitate the design and elaboration of some new methods and tools, not only for hosting and managing the contextual nature of multimodal and distributed data, but at an equal consideration, address and mitigate the constrains of technological complexity required as to achieve this goal. This parameter is grossly amplified by the fact that addressing such issues with the currently available range of public domain technologies, standards and tools, imposes a significant burden of itself, particularly in trying to fuse together heterogeneous tools and standards, under a common pragmatic deliverable. However, probably the most important issue –in non applied science terms- prohibiting use of several ambitious similar efforts, is the complexity and volume of required know-how and training effort by the field specialist, as to be able to attend to the requirements of the e-Research environment, without having to be qualified as an IT expert as well. These issues, among many trivial and multifarious considerations, have forged the orientation of the EUEDOS design team, as to deliver a workable and directly assessable solution being the primary consideration. The team has suggested an integral model able to initially host immediate demands and, progressively expand to the full potential of scope and vision presented by EUEDOS. The Repository module, introducing a seamless User Interface and overall operational environment for hosting advanced repository operations, at a Data Grid level of interaction and abstraction. The worldwide assessment and research in the field of Digital Information Repositories, has already offered an ample view to the problems and potential features of them, in fact proving their value and potential as next generation knowledge management and collaboration environments. However, the particular structural, formal, technical and operational details, remain widely open as to adopt and develop according to the ad hoc requirements of any particular design. The EUEDOS Repository, presents some of the most demanding cases in this field, by means of overall scope and diversity of requirements.

The above considered, along with the important denotation that the overall model proposed, as primarily being based and maintained by institutional establishments, should allow deployment in low cost server farms, but should not significantly jeopardize performance, or curtail the initial merits of e-Research vision assessed by EUEDOS institutional and civil members. Under these considerations the EUEDOS Repository environment was based on the following foundation platforms:

-Entirely Based on Java / JSP with MFC messaging classes for SMTP based messaging system, tuned for JAVASCRIPT/AJAX agile (asynchronous) rendering. JOGL (Java for Open GL) is also scheduled for near future advanced visualizations module.
-LINUX/WINDOWS OS independency (Java-based application should run on anything)
-Fully based on public domain WWW service delivery infrastructure, as is the Apache web server and Tomcat Servlet engine
-Uses MySQL relational database for node and cluster level server support

A spectrum of ancillary applications is also developed or being planned for the EUEDOS Repository. Collaboration among EUEDOS Repository users and institutions, is a major feature desired for implementing a true e-Research community of experts. Special care has been taken to provide users with an environment that facilitates the intercommunication among partners. There are four discrete tools and services that act on the field of users collaboration:

Messaging system. In EUEDOS Repository, an internal messaging system has been developed in order to implement the intercommunication between users. This is coming to satisfy an exigency that has been imperative in environments as EUEDOS Repository, mainly due to the inability of conventional email systems to effectively fulfil this role. Of course, the messaging system is not aiming to replace the email but to substitute it in some very particular cases. The message system can operate in two discrete ways. In the former case it is focused on the files stored in the repository where any file is bound with the messaging system, giving the users the capability to notify the other users about the existence of a file in repository, along with capability of appending comments and, with a facile retrieval mechanism. In the latter case, it would serve as a facile messenger between the EUEDOS Repository users.

The incorporated Email system. An advanced email system is currently under development in EUEDOS Repository, which can make possible the seamless interoperation between the conventional SMTP Server/POP3 Protocol type of services, and the EUEDOS Repository. Beside implementation of a standard email client, advanced functions are also anticipated, such as direct registration of an email attachment to the repository in one step action.

Document revisions. A conventional method for managing multiuser revisions is currently offered, and a prospective Subversion (SVN) method, as the back end for document versions maintenance, is also investigated.

Calendar. Calendar is a tool that facilitates the coordination of the users in an event based planning and registration.

Multimedia Publications Module. A state of the art module for developing highly elaborate multimedia publications with rich HTML, CSS, DHTML functionality is included, offering the benefits of open architecture and sustainable content management, via powerful incorporation to the Repository. The enabling feature for the user, is that no programming knowledge is required as to produce an advanced multimedia publication, as this is obtained via selection of a wide range of pre-built templates. Publication modules include a world class video rendering and automated indexing engine, as well as an audio recording, indexing, and narration driven CBT engine.

4. Conclusions

The overall design philosophy and development efforts for the EUEDOS (European University Enterprise/Education/Employability Databases Organization System). An introductory but thorough correspondence to the social, economical, structural and technological framework that is required by the proposed model to address, was attempted, with emphasis to the discipline most acutely targeted, Engineering and S&E. The anticipated pilot implementation areas over the second phase of the EUI-Net program (European University-Industry Network www.eui-net.org) was outlined, as a mature demonstration phase leading to results ready for adoption and policy forging. It was arguably postulated that technology driven solutions may implement and deliver a fully functional environment able to address cardinal issues and exigencies, for the European and American educational and labour reforms. Apparently, the results are of international application and significance. The longer term benefits from successive exploitation of a conceptually and technologically advanced, yet easily assessable and operable, knowledge capture, management and synthesis software infrastructure, was projected as of immense significance for timely managing technological higher education, but also as the dense research environment required for assessing crucial problems of the 21^{st} century, on a worldwide network of collaboration.

Designing an integral system attempting to address a serial of cumbersome issues, starting from technological education competency and up to employment rehabilitation, will inevitably have to satisfy both, long standing policy requirements along with technical challenges. However, the immense latent potential lays with the social perspective. An issue that should receive an exclusive consideration by itself, is the overall evaluation and consent cycle required to establish such a public credification system. This postulation is based on the mere observation that the true hindering factor for its implementation so far, has not been the absence of a technology framework able to deliver such an ambitious service. The core prohibits remain in non-exact factors and obstinately retained localized policies of Institutions blended with political constrains. However, the international status per se, can no longer postpone the devolvement to a system of certifiable values and actions, towards the new model of **life-through education and scalar employment opportunity**.

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