

Scenarios for Europe in 2020

Version 5.2, 29th July 2004

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0. Executive Summary

The High Level Expert Group (HLEG), advising the EC on the research implications of the converging nano, bio, info and cogno technologies (NBIC), requested the work reported here. Scenarios for Europe in 2020 were developed to inform the discussions of the HLEG on the development of research agendas and policy options related to converging technologies.

The outlines of the scenarios were developed in a workshop involving 11 members of the HLEG, two outsiders and two members of the EC Foresight Unit. After the workshop the report was written up by the editor, added to by the participants and two other HLEG contributors, and has been reviewed by an Editorial Board and the participants before being circulated.

We found that Europe in 2020 will be affected by a number of factors, including demographic change and technology advances, but the major effect of NBIC technologies in particular on the economy and society will be later than 2020. However there would be many specific industries and processes affected by NBIC technologies in the 2020 timescale, and thus research agendas well before then.

We considered that three main forces would determine Europe's participation in NBIC research:

- Public attitude to science and technology
- Europe's view of itself – culturally diverse or seeking homogeneity – with the associated political implications
- Europe's ambitions for economic growth, as expressed in the Lisbon Declaration.

By considering different combinations of the forces, we developed a number of scenarios² and chose to explore four. The approach to science and technology research in general and NBIC in particular under each could be described as follows:

Competitive Europe represents the “official future” as expressed at the Lisbon summit. Here, Europe would use science and technology to modify old industries and create new ones, focusing on export opportunities. Examples are

- topics related to sustainability, e.g. fuel cells, potable water, pollution monitoring
- health needs to develop export markets world-wide
- products for French & Spanish speaking cultures
- niche products for different climates

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Alternative Lifestyles would focus on industries facing structural change, using research to take them to a new totally sustainable economic model. Examples are:

- technology to support decentralisation
- energy smart solutions, e.g. bio-engineering to produce hydrogen
- programs to solve the greenhouse effect e.g. bio-engineering of plants to accelerate carbon dioxide take-up
- telemedicine
- artificial intelligence in support of education & the creation of know-how
- monitoring of the eco-system

Global Capitalism would concentrate research on export opportunities of capability, innovation and specialist products. Examples are:

- topics related to preventive health care – . predictive medicine, understanding human genome in terms of early diagnostics, epidemiology/public health, ecology, life style regulation technologies, IT technologies for analyzing huge data sets to aid the sciences
- brain enhancements that enhance information storage & retrieval
- Basic science still needs to understand relation between genes and diseases, which may lead to medical technologies; but also it requires technological support, for instance nano-technological analytic methods.

Regional Calm would focus on promoting inclusivity, with research on:

- cognitive issues
- bio-ICT issues
- harnessing new bio-/geno-technologies to extend significantly lifespan as well as quality of life. Emphasis on prevention rather than cure – reduces need for expensive “reactive” therapies
- robotics & artificial intelligence.
- topics related to sustainability, e.g. fuel cells, potable water, pollution monitoring

The topics which appear in all the scenarios are those related to health – preventive medicine, telemedicine, tailored pharmaceuticals, bio and ICT monitoring, etc. A focus on health & ageing would appear to be robust across all scenarios for an NBIC programme.

Sustainability (e.g. bio-engineering to produce hydrogen, programmes to solve the greenhouse effect, fuel cells, potable water, pollution monitoring) could be a robust focus if allied to export markets and export of capability, and used to drive economic growth.

The use of ICT is embedded in all the scenarios, as are assumptions about enhanced ICT capability and the knowledge economy – although this is not spelled out.

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Cognitive issues and brain enhancements are not seen in the scenario where the public is negative about science and technology (*Alternative Lifestyles*).

Common to all scenarios are links between universities, research, and industry. It is reasonable to look to a regional structure to implement this co-operation in all the scenarios.

The scenarios that are based on economic growth (*Competitive Europe, Global Capitalism*) have also a strong emphasis on basic research excellence.

The HLEG decided at its April 2004 meeting that, independent of views of Members of the HLEG, the group would orient its report towards the *Competitive Europe* scenario, while noting that other scenarios could occur and the EC 7th Framework Research Programme should be aware of this and revisit the views of the world in 5 years time. Subsequently, the low turn out in the European elections in June 2004 reinforced this caution.

The names of the scenarios in this, Version 4.0, have been changed from the earlier working titles to be more accessible to the external reader.

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1. Introduction

This document forms the record of a Scenarios Workshop, part of the work of the High Level Expert Group advising the EC on the research implications of the converging nano, bio, info and cogno technologies (NBIC).

The objective was to develop a series of scenarios to be brought back into the main working group for the development of research agendas and policy options related to Converging Technologies.

The Workshop was held at Hinxton Hall, Cambridge, from 26th to 29th February 2004. The attendees are listed in Annex B.

At the start of the Workshop we agreed that we wished to create 2 or 3 realistic, self-consistent scenarios (using Porter's definition, not a forecast but a possible, credible outcome). We were looking for:

- clarity on key issues
- 2 or 3 differences between a European and North American converged NBIC technology world
- the link between the technology and economics
- ability to formulate research questions for 7th Framework Programme
- the adoption of a common technology roadmap
- application of the Principles guiding the overall project (Annex A)

The approach taken has been to assume in some sense the existence of a series of technology road maps to 2020, and to focus on the social and economic environment, and hence the implications of NBIC where these road maps converge.

This document will go through three Versions before being circulated at Version 3 to the HLEG Group. This is Version 2, for final comment by participants. Note that this version has some gaps in the scenario descriptions but my personal view is that we can use what we have to drive the work with the HLEG.

Version 3 will be used to support a discussion at the April meeting of the full HLEG on the implications of the scenarios in terms of

- robust recommendations on NBIC research topics and infrastructure

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- early indicators & decision points where scenarios suggest different approaches

Version 4 has been updated from Version 3 with more transparent scenario names to make the report more accessible to external readers.

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2. Assumptions about 2020

Scenarios explore areas of uncertainty, within the context of the best information possible about the forecastable factors.

The assumptions about the world in this section were those agreed by the group, augmented by points from input papers by contributors. The full set of items suggested by the group are listed in Annex D.

The technology assumptions are those proposed by the experts as having a potential impact by 2020 – i.e. the lab results were already clear but there could be questions about usage and extent of impact in the timeframe. The technology “roadmap” was emphasised to be less like a modern atlas or gazetteer and more like a medieval map, with “here be danger” and “wild beasts” scattered across.

Assumptions about the world

GLOBAL ENVIRONMENT

- Climate change, potential unexpected side effects of warming at the Poles
- Instability of the political and economic environment not just wars/conflicts: at least one crisis before 2020
- Societal change over the next 20 years strongly affected by the broad diffusion of information and communication technologies
- Globalisation of the economy, mainly of finance, but also of production, is accompanied by globalisation of communication media
- More pronounced trading blocks
- Physical constraints – oil & gas prices increase, pressure on potable water.
- Increasing weight of Asia, with India & China as competitors to Europe
- Global growth comparable with 1970 – 2000, i.e. about 3% pa
- China and India are major economic and military powers based on their technological prowess, large increases in middle class & graduates
- The main world languages are Arabic, Chinese, English, Hindi, Spanish.
- The investment in NBIC from US venture capitalists in 2003 swamps that from NSF.

DEMOGRAPHICS

- growth of the world's working population will fall from 2% between 1970 to 2000, to 1.1% for 2000 to 2030
- All regions of the world will experience demographic ageing as birth and adult death rates slow simultaneously
- In the rich countries, such ageing will lead to a fall in the working population and a rise in the number of older people: with consequent tensions between workers and retirees “we pay, you play”

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- In contrast, in the poorest countries, demographic changes will lead to an increase in the size of the working population, as the share of the under-15s declines
- Significant immigration is expected, to urban areas and from poor countries to ageing rich countries

EUROPEAN ECONOMY

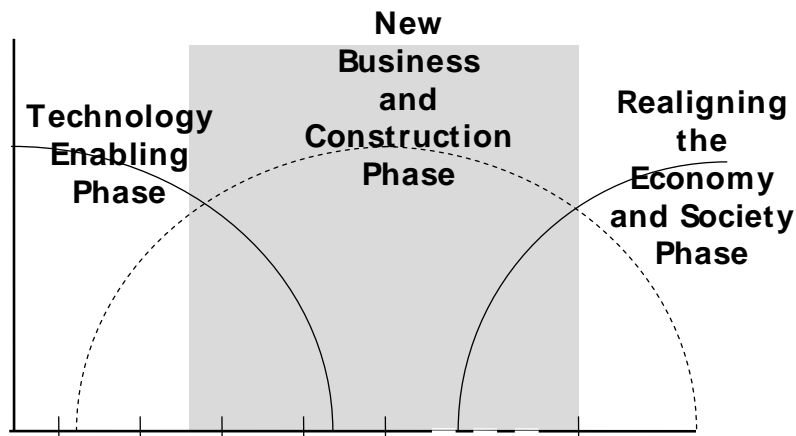
- Europe has increased range of minority religions, nationalities & languages
- Problems of shrinking tax revenues from shrinking working population and informal economy
- Relocation of production from Europe
- Growth of services, entertainment and leisure sectors
- European firms depend more on markets outside Europe
- Europe will continue to have governance functions at EU, national and regional levels.
- Europe is a consumer driven society with individual attitudes to self management by 2020.
- Broadband IT will mean that the included are well informed and able to choose options outside their region or Europe, i.e. globally

Assumptions about NBIC

The group assumed that unless developments were in the lab now they were unlikely to affect society by 2020. The lag time from demonstration of capability to introduction is typically 5 years (new materials, health sector, pharmaceuticals), and for those in agriculture and energy, 10 years. The effect on society in economic terms is likely to be several years later. This list therefore focuses on capabilities demonstrable in the labs now.

Below is a diagram representing these stages.

Technology-induced change



Based on Gartner Group

St Andrews Management Institute (SAMI)

BIO

- Pharmacogenomics and personalised medicine – these will accelerate the approval process and shift attention from block-buster drugs
- Bioterrorism [viruses] – something will happen, we do not know the exact form or when
- Bio-based agricultural economy (e.g. modified algae to generate hydrogen)
- Nanobotic laboratory with lab techs replaced by robots
- Bio-engineered bugs e.g. to monitor or counter pollution

NANO

- Computer based/invasive monitoring and treatment of health and disease [effect on need for hospitals]
- Cheaper energy sources e.g. from photovoltaic cells
- Convergence of food, cosmetics and pharma technologies e.g. generation of tailored foods as well as medicines
- Designer leisure drugs

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- Materials science produces more bio-degradable products
- Thin screens and broadband impact leisure and household management

INFO/COGNO

- DNA to assemble circuits for IT: contenders for new implementation technologies (processors, storage) will cause market confusion
- new generation of computer products: themes are miniaturization, multimodal input including natural speech, images becoming more important
- AI is very powerful in a much wider range of tasks, more intelligent than humans: but software of complex systems to support failure conditions lags
- Sensor networks, surveillance, data gathering by governments
- personalised/localised personality broadcast, digital pheromones: use of wireless technology dominant
- convergence of bio & IT instrumentation in the skin/artificial skin & smart coding in the skin – tagging by states and monitoring for health problems by individuals
- nano scale intelligent autonomous agents for medical repair e.g. cleaning out arteries, stomach operations

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3. Building and selecting the scenarios

AGENDA – day 0

After dinner we watched a very bad Horizon programme on nano-technology, illustrating the problems of popularising science. This highlighted the question for us of public perception of science. The programme will be influential on public opinion. It was – we all agreed – poorly presented and scientifically incorrect. The S&T community needs to be concerned; meanwhile the public is doubly sceptical.

AGENDA – day 1

- introductions & clarify roles
- agree aims of the workshop (above)
- agree scope of scenarios:
 - societal and economic descriptions of Europe in 2020
 - including potential impacts of technology developments to 2020
 - discuss economic model, governance dimensions
 - lead to scoping of research issues
- discuss what is interesting in/about inputs (list, use as prompt for scenarios – see Annex G), including input on attitudes to science & technology from Euro barometer project (CG)
- Table important forecasts for the world in 2020 (see Annex D)
- What are the important questions/uncertainties affecting Europe in 2020 – see Annex E: These were grouped into four major drivers:
 - will public attitudes towards science and technology be positive or negative (Yes or No)
 - is diversity developed and nurtured as a positive aspect of Europe, or is there a drive towards homogeneity (Yes or No)
 - will Europe tackle the Lisbon agenda with a focus on the economy (E) or social equality/cohesion (S)
 - will governance (government, tax, regulation/harmonisation etc) be centralised at the European level (C) or decentralised (D)

Other items were “Wild Cards”, handled by exception, see below

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- create 16 scenarios by considering possible combinations of descriptions – see the chart in Annex F – each scenario was described in terms of Y/N, Y/N, E/S, C/D.
- five combinations were voted by the group as of interest to pursue further:
 - YYED – positive public attitudes to science and diversity, economic drivers, decentralised governance
 - NYSD – Negative attitudes to science, positive to diversity, social cohesion as a driver, decentralised governance
 - YNEC – positive attitudes towards science, negative to diversity, economic drivers and centralised governance
 - YYSD – positive public attitudes to science and diversity, social cohesion as a driver, with decentralised governance
 - YYEC – positive public attitudes to science and diversity, economic drivers and centralised governance

In the evening we discussed Goethe's Faust and the application to our task under RK's tutelage. He highlighted the dilemma of the scientist even then. Goethe was torn between the roles of researcher, academic, innovator and businessman, and found it difficult to make a series of moral judgements about his work and the benefits – for whom?

AGENDA – day 2

- Input from TG on potential social collapse in 2010–2015
- review five scenarios & decide to adopt 4, regard governance issues as to be defined under each scenario:
 - COMPETITIVE EUROPE – public attitudes towards science and technology positive, diversity a positive contributor to Europe, Europe tackles the Lisbon agenda with a focus on the economy
 - ALTERNATIVE LIFESTYLES– public attitudes towards science and technology negative, diversity a positive contributor to Europe, Europe tackles the Lisbon agenda with a focus on social equality/cohesion
 - Global Capitalism – public attitudes towards science and technology positive, diversity a negative contributor to Europe, Europe tackles the Lisbon agenda with a focus on the economy
 - Regional Calm – public attitudes towards science and technology positive, diversity a positive contributor to Europe, Europe tackles the Lisbon agenda with a focus on social equality/cohesion
- topics to consider under each scenario:

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- governance
- regulation/harmonisation/standardisation
- economic model, effect of NBIC to accelerate or retard
- public/private sector
- public 'common goods'
- relationship to natural world including sustainability
- research infrastructure
- timeline
- early indicators
- how would the scenario cope with Wild Cards? These issues were those that were independent of control by mechanisms in any of the scenarios, but could derail all scenarios. See Annex H for a more detailed discussion. We focused on a few e.g.
 - global warming e.g. effect of The Hague under water in 2007
 - CERN generates a black hole (an example of the dangers of scare stories – my advice is that CERN energies would just about annihilate a virus if in the wrong place)
 - Guerrilla wars, hostilities, & conflicts (particularly low tech)
 - economic instability e.g. US consumer boom collapses, war in China
 - social crisis in 2010 – 2015 in Europe

In the evening one group held a robust discussion of whether we had usefully explored the relationship between NBIC and economic performance. And the sense in which we had a road map of the technology capability becoming deliverable by 2020.

AGENDA – day 3

- extend scenario descriptions to cover
 - Science & Technology topics in each scenario
 - industrial sectors & public sector effects
 - research infrastructure
- review against principles & agreed aims
- decide next steps (see Section 1 above)
 - shape of the output document
 - process & timescale
 - Editorial Board: Kristine, Alfred, Ottillia, Raoul
 - HLEG use of scenarios work

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4. Four scenarios

Note that all scenario descriptions use the same set of headings but working groups differed in the emphasis they gave to specific headings.

Note that some NTW EG SIG Reports may refer to the scenarios by their earlier, working, names. The earlier names were: McDonalds – now Global Capitalism; Dragon – now Competitive Europe; Alter – now Alternative Lifestyles; Hubbard and Cupboard – now Regional Calm.

4.1 Competitive Europe

Reason for the name: This scenario looks for ways in which Europe can become a major growth motor like the Tiger economies of Asia, highlighting the economic targets of the Lisbon Agenda.

Description: (include the main drivers and who is a hero researcher/entrepreneur/ what is typical newspaper headline)

- public attitudes towards science and technology positive,
- diversity a positive contributor to Europe,
- Europe tackles the Lisbon agenda with a focus on the economy

A cautious technophile society, social concerns taken care of by growing the GNP and sharing wealth: typical characters are:

- Charpac – the French Nobel laureate
- Kennedy – JFK took the challenge and got man to the moon
- South Korea – economic tiger
- Mansholt – for early agrarian reform in the EC
- Venter – entrepreneurial attacks

Entrepreneurs and spin-offs highly regarded – entrepreneurial spirit as defined by Schumpeter, underlying the innovation process

Economic model, effect of NBIC, role of public & private sector, role of “commons”

- Schumpeter (entrepreneur as hero) x Hayek (free markets are the only way)
- Science & technology a major instrument of economic development
- By 2020 a competitive knowledge based society
- Economic model supports corporate euthanasia i.e. allowing firms to fail

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- Create new industries
- Apply NBIC to traditional industries and absorb the impact on jobs etc
- Throw money at centres of excellence in pure research to look for breakthroughs, emphasis on knowledge based economy: note the need for long term funding in basic research
- Focus on external competition, and internal co-ordination
- Use diverse European social, economic and operational models and market to develop products for export, e.g. to French-speaking & Spanish speaking local markets and countries, and niche products for different climates & needs, different educational requirements etc
- Health needs of Europe used to develop export markets worldwide
- Better University-industry co-operation

Governance: & regulation, tax, standards:

Social conflicts: effects of NBIC on internal conflicts and wars

Sustainability: effects of NBIC

- Work on sustainability underpins exports e.g. fuel cells, potable water, pollution monitoring
- Probably a priority by 2020

Science & Technology topics – focus and why

Effect on industrial sectors & public sector activities (include Hospital medicine/telemedicine, education, agriculture, artists, trade, and manufacturing)

Research infrastructure

- Need to support speed, flexibility, maintain good foresight
- Facilitate fast track
- Subsidiarity model & better use of existing instruments e.g. Framework Programme, Articles 168, 169 in EU treaty.
- More transparency & democracy in the process of funding, well defined criteria
- Concentration to get critical mass, centralising activities at European level, may be small units but centres of excellence

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How to identify future trends

- New instruments – early warning units

Effect of Wild Cards

- Explore use of S&T to give early warnings
- Global warming a source of tension between US & Europe
- Diversity approach limits guerrilla wars to small regional campaigns
- If it does happen & cause widespread damage, lots of blame around

Early indicators of the scenario developing

- Improved co-ordination – increasing by number and quality the joint activities as foreseen in the European Research Area and the measures for it in FP6.
- National government commitments on co-ordination & budgets
- Financial perspectives to 2010 – demonstration of seriousness by EU Ministers and the European Parliament – and the amount spent on FP7.
- Competitive Europe spirit of speed & flexibility, encourage “just do it”
- Utilise jewels, think European without envy
- Delocalisation of research
- Create success stories & share existing ones we have already e.g. GSM
- European dimension in national awards

Timeline

It is questionable how many NBIC developments can be integrated into society by 2020.

4.2 Alternative Lifestyles

Reason for the name: This world is against technology, with people looking for alternative lifestyles, medicine etc .

Description: (include the main drivers and who is a hero researcher/entrepreneur/ what is typical newspaper headline)

- public attitudes towards science and technology negative,
- diversity a positive contributor to Europe,
- Europe tackles the Lisbon agenda with a focus on social equality/cohesion

The public distrusts science. The combination of the arrogance of scientists and their mercenary attitude towards military procurements and big companies' interests,

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feeds this feeling. The idea that the « invisible hand » picks into the taxpayer's pocket for anonymous shareholders' enrichment from killing and polluting firms is increasingly intolerable.

Some aspects of the public perception of science are:

- Wide range of grey goo style potential nightmares in public eye
- IT increases gap between rich and poor
- Impacts on free time and pace of life: downshifting
- Increases personal uncertainty about the future, hence decreases happiness levels
- Entertainment more readily available over the net, cultural competition
- Environmental monitors
- Better recycling due to tags
- Information pollution
- Computer initiated science and technology, people can't understand systems that run our lives

The distrust expresses itself through the NGO movement, directly from the public, self organizing through internet. Amateur scientists as well as professionals, disgusted by their employers' practices, contribute to the debate.

The controversy does not lead to a static opposition between Science and public opinion, but conversely leads over time to an intelligent response of the scientific community, who reorient research towards directions serving the common good.

Economic model, effect of NBIC, role of public & private sector, role of “commons”

The Care economy would see more social involvement by companies and a decline in globalisation.

Governance: & regulation, tax, standards:

This scenario encompasses an alliance between the European Commission and the regional authorities. These, worried by the industrial delocalization generating massive unemployment problems, tend to build a strategy based on local clusters of competence, specialized, not on big science, but on excellence in daily life technology. To be efficient, such clusters are precisely defined and visible worldwide through the Internet.

(Already some regions, like for instance Toulouse, had in 2004 a speciality visible from the other side of the planet – aerospace – and could claim world class excellence. Others, like Burgundy on wine and cheese, facing international competition, were starting to support existing ability by new scientific inputs through dedicated research poles).

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After all, this was the standard historical pattern in industrial developments, for centuries relying on local nucleus of competences. It was also an illustration of the well known advice: « Think global, act local »

Technology would be used to support the decentralised style of governance e.g.

- Electronic voting
- Electronic shadow democracy
- Community networks give higher feeling of involvement in decision making
- Democracy on the fly via smart clothes etc
- Use of network communities v geographic government – power to pressure groups, e.g. environmentalists
- Centralisation of IT to control workers, more work stress
- Monitoring v privacy
- Biometric sensors
- Network life
- Primary influences not from local community

Social conflicts: effects of NBIC on internal conflicts and wars

Issue of man v nature

- 21st C piety re improving technology due to lack of public understanding of Science & Technology
- increasing globalisation caused by need for scale causes feeling of disenfranchisement
- use of technology by government to police crime, concerns over invasion of freedom
- anti-technology feeling grows until 2010 at least
- Use of technology as a means to police racist attitudes, racial offenders could have emotion tags

Sustainability: effects of NBIC

This pressure of public opinion on Science through public debate is in a first stage, perceived by some scientists as an intrusion of irrationality in the temple of reason. We know now that a moratorium on nuclear energy might not be the best way to solve the greenhouse problem.

More difficult choices will challenge again opinion rationality : for instance genetically modified plants might be able to get their nitrogen from the air without fertilizers, avoiding the presence of nitrates in our drinking water. Should they be banned only because they are GMOs ?

On this type of question, the debate is expected to last a long time and to be full of arguments. But the public, and particularly the rising NGOs are, through Internet, much better informed than in the past. They organise networks as influential as the big firms lobbies. Their position has to be taken into account.

Science & Technology topics – focus and why

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The population is diverse and the diversity is strongly valued and protected. Political correctness is used to engineer social cohesion, with strong regulation enforcing respect between communities.

Language translation technology is a focus. (Last 1% needs machine consciousness to solve)

Effect on industrial sectors & public sector activities (include Hospital medicine/telemedicine, education, agriculture, artists, trade, manufacturing)

Below are seven domains of activity, in which converging technologies generate deep structural changes. In this scenario, the European Commission sets up important programs funding research and developments in these fields, using the Think Ahead Principle.

1– Energy

Energy saving turns to be the main goal. Instead of considering as a need what is merely a waste, the search turns to smart solutions : hybrid technologies for heating and electricity production, hybrid cars, recycling and renewable materials, development of public transportation.

The shift of research to societal applications drives the mobilization of converging technologies: programs were launched to solve the greenhouse effect. GMO's, formerly used to enrich excessively wealthy farmers, were turned to invent new plants, some of which were able to accelerate carbon dioxide absorption and others to produce hydrogen.

Under the Think Ahead Principle, monitoring of environmental factors is a key factor.

2–Health

The health care system is deeply transformed by the development of telemedicine, which allows most patients to be followed and cured anywhere but in a hospital. This also leads to self care. The patient becomes his own doctor. He is assisted by Internet information and Artificial Intelligence diagnosis softwares. A new cognitive approach of one's own body arises (Yoga plus High tech): from health care to illness prevention, using diet, health standards and lifestyle recommendation.

The movement illustrates the think ahead principle, driving the whole new Science and Technology policy. Under that principle were developed different types of measurement instruments and sensors to support health quality.

3–Education

Education of the 20th century was mainly driven by industrial needs, to train employees, and training for daily life abandoned by 20th century schools

The 21st century needs less employees and more employers, therefore more self management and self sustainability.

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So education is deeply transformed, not only through Internet storage of knowledge, which makes it accessible from any place on the planet, but mostly through self management, self care, self testing, self sustainability and, above all, self training. This does not mean selfishness, but individualization plus cooperative processes of training. A model is the free software community of 2004. Regarding educational institutions, collective intelligence training takes the leading role. Know-how appears to be the key factor, as knowledge is now freely available through the Internet. And this know-how concerns daily life as well, for self sustainability

4-Art

Art is definitely considered as a part of research. In an economy made of small firms, most entrepreneurs have to give a personal touch to their presentation. A small wine maker from Australia shows his house and his family, creates his website for distant orders. In all these activities, an artistic component is present; therefore artistic training is needed for the majority at school level.

Anyhow, in a cognitive civilization, Art is not only promoted by trading activities. It is a basic component, a cement of society. The word of Paul Klee « Art does not reproduce the visible, it makes visible » must be remembered. Cognitive enrichment needs Art.

5-Agriculture

The case of biosphere preservation is a subject of particularly attentive care in this scenario. Studies are launched on natural dynamics of the number of species, taking into account the fact that mankind has already transformed nature into a techno-nature, for which he bears the responsibility.

Satellite monitoring of the ecosystem is continuous.

The idea of « sustainable development » has been a temporary compromise. The true mission of mankind is to be the gardener of the planet, and the servant of beauty. Nature is a common good, as well as language and science.

6- Property and Trade

Patenting of life is declared illegitimate. Academic writings and science results are freely accessible. Open software replaces the commercial software. Internet blows away the copyrights of text, videos and music. Freedom progresses through technology, at last !

Not only property rights, but trade as a whole is « impacted » by the converging technology wave. Consumerist information develops, testing facilities multiply. The reliability of trade through Internet is difficult to establish. Social studies are necessary to analyse the mechanism of reputation building.

But the intervention of Justice, which had been primarily invented in Mesopotamia to solve interest conflicts and prevent swindling, is presently overwhelmed by information. Reinvention of judicial action in an Internet trade context is a prerequisite for the healthy settlement of the new economy.

7-Money and capital management

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The response to social, economic and monetary crisis, the permanent threat due to the irresponsible volatility of international stock exchange markets, lies in building local self sufficiency, using internet for LETS (local exchange transaction systems) which escape the consequences of currency fluctuations.

The world of the beginning of 21st century is not a capitalist economy. Capitalism only works for a small minority of big firms, and a few small ones through venture capital. Less than one firm in a thousand in Europe is concerned with the open capital market, working as family firms or private concerns. In the future society based on small business, local or professional capital markets have to be built and operate more widely.

Research infrastructure

Possibly following the US model, with Federal funding located in a region following support arrangements and matching funding etc agreed with regional government and industry.

How to identify future trends

Effect of Wild Cards

The social crisis speculated for 2010 to 2015 would affect different regions differently. Mobility between regions would increase.

Global warming is tackled by regional or national governments, often involving movement of people away from the local area affected.

Guerrilla wars are more like gang warfare, often related to the rich–poor gaps. Society supports electronic tagging as a deterrent.

The black hole experiments at CERN have been cancelled in this scenario.

Early indicators of this scenario developing

The GBN³ scenarios published by the Pentagon forecasting for instance The Hague under water by 2007.

The conflict between the US Government and scientific publishers over the publication of academic research results from workers in countries under commercial embargo.

Timeline

A reaction to the social crisis of 2010–2015 and the backlash against science in the timeframe leads to modified attitudes to science by 2020.

³ Global Business Network

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4.3 *Global Capitalism*

Reason for the name:

This scenario implements the US model within the EU, which prompts the question on our sources of comparative advantage

Description: (include the main drivers and who is a hero researcher/entrepreneur/ what is typical newspaper headline)

- positive attitude towards science and technology
- equalises cultural differences in terms of access and opportunity
- economic competitiveness more important than social cohesion
(Europe emulates US–federalism)

Economic model, effect of NBIC, role of public & private sector, role of “commons”

- economic competitiveness no longer depends on labor cost, price of energy but on available manufacturing technology
- incentive for flexibility – project-oriented cooperation between researchers and companies
- export-dependency increases, but what is exported are manufacturing capabilities, technological innovations, specialized high-technology products for which there are few competitors
- indicators: dependency on foreign oil (is it decreasing?), number of European patents in new technologies, trade-balance
- new economy in leisure and entertainment – private lives will be increasingly permeated by entertainment technology
- the entertainment industry will exploit opportunities of global marketing for targeted audiences
- economic migrants will be recruited, incentives for retention of skilled work-force in Europe

Governance: & regulation, tax, standards:

- strong federation with common foreign and economic policy, security/military, official language, educational /training system, trade and labour laws
- cultural issues left largely out of federal politics, sense of identity economically as Europeans but culturally & sporting as national, regional, ethnic

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- European elections would become more important, also there'll be more passionate attitudes (pro and con) toward federal government which is very important but also far – a European identity emerges
- critical indicator of public participation and support of this Europeanness: direct election of European president, participation in elections, European parties
- recognition of need of regulation: one process for product approval, one standard, common European, perhaps international standards
- overall, regulation will set common playing-field, allow greater risk and economic opportunity, the European consensus will be on lowest common denominator (avoidance of greatest generally recognized risks) – risk-avoidance largely delegated to economic interests
- sustainability achieved by technological means – reducing ecological footprint (more energy-efficiency)
- will the precautionary principle be in effect (how narrowly will it be interpreted)?
- what is democratic input into this regulatory process?
- will there be restrictions on research? unlikely, but consider the inherent sources of social conflict
- radicalized minority as it feels that economic considerations permit technical developments which leave no consumer-choice but pervade all social life

Social conflicts: including effects of NBIC on internal conflicts and wars

- cultural tensions as policies discourage ethnic, cultural differences in public life (indicator: will migrants be “integrated” as Europeans or Germans?)
- traditional, techno-phobic life-styles become counter-cultural

Sustainability: effects of NBIC

Science & Technology topics – focus and why

What will be the research priorities and funding mechanisms of the 11th framework program?

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- One priority would be preventive health care (i.e. predictive medicine, understanding human genome in terms of early diagnostics, epidemiology/public health, ecology, life style regulation technologies, IT technologies for analysing huge data sets to aid the sciences – it will depend on economic promise how much of this will be done and in what order of priority, maybe putting last any social programs for stress-reduction and enhancement of general quality and ease of life).
- Could Global Capitalism Europe counteract voting and consumer pressure towards any medical/technological advance in the treatment of ageing as a curable disease, extending average life-expectancy to 150 years?
- If brain enhancements became feasible, Global Capitalism Europe would probably not say no, even in face of criticism that this will create social injustice and coercive pressure on everyone to get one. Global Capitalism Europe would surrender its political will to consumer demand.
- Case of genetic science: Basic science still needs to understand relation between genes and diseases, which may lead to medical technologies but also it requires technological support, namely nanotechnological analytic methods. Basic science as well as development of applications is large scale and cross-disciplines

Effect on industrial sectors & public sector activities (include Hospital medicine/telemedicine, education, agriculture, artists, trade, and manufacturing)

Research infrastructure

- European Research Council is a major source for discretionary research funding
- public/private partnerships will be a priority, universities expected to deliver technology transfer, spin-offs, etc.; universities operate increasingly like enterprises – university sells its services to the industry, including profit-sharing; academic research on contracts rather than tenure; research funding by industry increases in absolute but not proportionate terms (but the proportion of industry-funded research doesn't)
- academic research has closer links with industrial sector (European patent act is adopted across Europe)

How to identify future trends

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If we compare current European policy to the *Global Capitalism* scenario, what procedures, mechanisms, sensibilities should be in place to identify worthwhile S&T trends?

Now: “experts” are brought in to identify the state of the art and to assess prospects for already identified trends.

In *Global Capitalism*, the European Research Council will have longer-term appointed experts (that draw also on international peer review). There will be mechanism for integrating technological needs of science (science is recognized as a driver of technological development) and the scientific interests of technological research agendas.

Fast tracking mechanisms will be in place (greater responsiveness) – especially in regard to technological work, the expertise of industry (as a sensor of novelty) will be drawn on increasingly.

There will be expertise in managing intellectual property, driving translation of research results into applications. Better protection of the intellectual property that serves as the basis for competitive technologies.

If we compare current European policy to the *Global Capitalism* scenario, what procedures, mechanisms, sensibilities should be in place to acknowledge and respond to public concerns about S&T trends? There will not be a government-initiated emphasis on pre-emptive, consensus-building measures to build a culture of trust in an ever-polarized society. This might happen as the interests of business and government combine. Otherwise, dissidents will be invited to build consumer pressure and to take their objections into liability courts, etc.

How will vested interests by industry and government be affected by the S&T innovations that we want to foster?

What is business doing, what are other global players doing and what is left for Europe government to encourage? Will *Global Capitalism* Europe stimulate alternative energy research, agricultural innovations (e.g. food and hydrogen from algae), environmental infrastructure? Depends on the strength of vested interests and the economic model, e.g. whether Neo-Keynesian views consider public works as source of economic strength.

Effect of Wild Cards

Global Capitalism has little interest in stifling economic growth now because some disaster might happen down the road, especially since slowly approaching disasters like global warming have opportunity costs when they come within striking distance, e.g. by creating an entire new markets, employment needs, etc.

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While the black hole (if it did kill off the whole of Europe) would be simply be the end for all scenarios, economic instability is a way of life. Global Capitalism expects the collapse of the US consumer boom collapses and prepares for it by maintaining a strong consumer base even as the work-force shrinks – by spreading work thin, delicate redistribution of wealth and by comparatively generous economic support of retirees, the unemployed, etc. *Global Capitalism* Europe exploits a weakness of the American economic system that more quickly exhausts its credit-limits. As part of its economic-homogenization efforts, it thus recognizes the need, above all, to avoid a crisis of the European welfare and social systems.

Guerrilla wars attack the uniformity of *Global Capitalism* Europe and guerrillas become folk heroes to the disaffected.

Early indicators

- no ban on human cloning

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4.4 *Regional Calm*

Reason for the name: This scenario is a view of a Europe which tries to “have it all” in terms of lifestyle.

Description: (include the main drivers and who is a hero researcher/entrepreneur/ what is typical newspaper headline)

- public attitudes towards science and technology positive,
- diversity a positive contributor to Europe,
- Europe tackles the Lisbon agenda with a focus on social equality/cohesion

In this scenario, S&T adoption, with an emphasis on social inclusion, produces economic growth, prosperity and comfort through an increase in a socially diverse service sector, which focuses on cultural intangibles.

Survival model – failure of big political systems.

Sustained by a peaceful world; self-regulated trade systems

There is no military capability; so less overheads; and security is subsumed under a regionally stronger, European driven umbrella Defence Organisation, EDO.

Characteristic people are:

- Politicians: – part-time entrepreneurs – a totally transparent and open system reduces corruption.
- Criminals – perform functions that optimise societal returns (pay back by working for society).
- Technology adopters and adapters – highly valued because of aligning us with the market place
- Entrepreneurs – complement the technology adopters, creating products and services.
- Citizens – view themselves as belonging to a *region*, but are essentially European.
- Ageing population – medicine markedly reduces the impact of degeneration. Death is quick, live long die fast.

Economic model, effect of NBIC, role of public & private sector, role of “commons”

Our society has assessed the risks, and is taking an acceptable route of economic and social optimisation, taking into account a mix of ethics and cultures, and human scale aspirations. This approach is attractive to a variety of creative individuals, who reinforce out cultural stock.

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Demographic shifts (ageing etc) are accommodated by a flexibility related to a willingness to accept social perhaps over economic returns. The loss of the impatient young (who go elsewhere to achieve their ambitions) is balanced by the influx of the mature (wealthy returnees?) that prefer the quality of life we offer.

This is a sustainable model because it incorporates a diversity of culture and languages and optimal uses of resources; enterprises are more like traditional family based organisations, adopting appropriate technology, caring for employees and ensuring continuous lifelong learning for social and technological relevance. There is strong social cohesion because of the nature of regional clusters.

This idealised society allows the development of families of technology based innovations which reach out to world markets via largely electronic means. Because this Europe is highly connected; it can commission relevant research to take place elsewhere, while retaining the IP to exploit globally.

Because of regional characteristics, there is an increased use of local exchange tokens / the barter economy in many transactions. There is a strong belief and support for the adoption of global standards for interoperability and the exchange of technical and cultural information.

The economy is a visionary one, based on the modification of existing, rather than new technology (although this does occur in support of the aims of inclusivity). Innovation focuses on health, the ageing population, smart communications, sustainability and maintaining self sufficiency in food production where possible, which necessitates a healthy respect for biodiversity and the environment.

Our low stress environment, and focus on prevention rather than cure, reduces the need for an expensive medical service. People pay the medical service to stay healthy; and use technology to make lifestyle choices.

Leisure economy is different

- Outreach 'networking'; communicating via the internet. Learning is important.
- Fuel efficient 'Transport on Demand'
- Rural / unpopulated areas protected and maintained. A small population means recycled housing.
- Religion is alive and well; humanism rules; people love school!
- Sport – a great outlet for aggression; and natural instinct to gamble and take risks. Special games would be supported by Government
- Non-habit forming (!) drugs are allowed. The danger is they may get out of hand.

Governance: & regulation, tax, standards: *How Did Devolution Happen?*

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This came about because Member states couldn't agree on their common future (not an unreasonable scenario!) so the European policy of subsidiarity meant that, as a default, it directly devolved to the regions via the appropriate structural funds (previously earmarked).

Regarding democracy – we vote individually almost on all on local and regional issues, using electronic means. The economy is not defined by GR(egional)P – so there is high level of hypothecated (democratically directly allocated) taxation.

A series of institutions will be created and supported to deal with pan-European issues such as Aids etc. Otherwise it is a very regional model; relationship is constructive because it is a complementary model.

Social conflicts: effects of NBIC on internal conflicts and wars

Sustainability: effects of NBIC

Biotechnology use is based on highly developed agrarian applications; and optimises the availability of natural materials and resources, maintaining biodiversity as far as possible. Regionally based products are supplied to the Body Shop (!). The region also uses all available technologies that help optimise the promotion, sale and distribution of products and cultural artefacts.

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Science & Technology topics – focus and why

1 Cognitive issues

As we are technology adapters and adopters; we focus on the cognitive aspects – especially in relation to seamless communications. Our all-pervasive computing will contain token ‘rings’ such as family rings; social and business rings; the latter being linked to our niche markets in the wider world.

External connections are designed to create relationships that build trust; and will develop into value networks. Communications will be built on cognitive paradigms that reflect human, rather than machine, relationships.

The capacity to create, maintain and deliberately mobilise effective networks – for bonding, bridging and linking social capital – becomes an essential factor of social inclusion, allowing the population to access to key resources such as income, knowledge, and various forms of social support.

Research will have to ensure inclusivity of all stakeholders; including the old and disabled.

Many of the interfaces (which will be non-obvious) and facilitated through micro and nano; will enable all to gain a minimum level of capability; rather than focus on the creation of ‘super humans’. The system itself must be able to capture the collective knowledge of society (tacit and overt) that is relevant to our lifestyle.

2 Bio ICT Issues

Research will focus on the human / communication interface; and ensure inclusivity of all abilities and capabilities; supporting them to a deeper level, with all the implications that presupposes.

Technology will aim to ameliorate the reduction of degenerative competences of all ‘six’ senses in the aged or sub optimally ‘fit’, ensuring they remain part of the e-connected society. (We will be researching the potential of the ‘dark’ genome, in terms of what ancient capabilities could be resuscitated that might contribute to our society!).

Research will also be undertaken on identifying and gathering early, weak signals of disease in humans, animals, and in agriculture; and how this can be monitored on a wide scale; non-invasively. This will lead to a universal, but customised, system of health and well being (an occasional breach will be permitted!); and minimising the manifestation of illnesses in relation to each individual genome.

Society will use robots to do low added value routine tasks. They will be easily programmable and downloadable with basic ‘common sense’. Vocational robots will be used for logical (household / agrarian) tasks

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3 Biotechnology

Research will aim to optimise the natural agricultural cycle, improve biodiversity, increase sustainability, and reduce the environmental footprint. Research will also take place into food production and preparation, which will be geared to meeting different individual health and cultural requirements – ‘personalised food chain’; and incorporate required therapies. Energy production will be in the main biotechnology based (agrarian); though the future ease of use and cheapness of other renewables such as solar, wind and water power means they will all be pervasive in the community.

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Effect on industrial sectors & public sector activities

Energy

- Personalised energy units
- Dispersed energy facilities for communities
- Fuel-efficient transport on demand

Healthcare

- Investment in harnessing new bio-/geno-technologies to extend significantly lifespan as well as quality of life. Emphasis on prevention rather than cure – reduces need for expensive “reactive” therapies.
- Convergent technologies permits design of facilities to be small-scale and distributed across regions, ensuring easy access for all. Investment in extensive adoption of patient-friendly tele-medicine.
- Synergy between healthcare and nutrition means that “health-status-adjusted” GNP becomes an important measure of societal progress.

Agriculture

- Sustainable food production, personalised food production
- Biodiversity and environmental nurture
- Emphasis on regional self-sufficiency, harnessing appropriate eco-friendly technologies

Education

- Investment in life-long learning, on a community basis
- Education is highly valued: citizens recognise the need to adapt to new knowledge and learning systems
- Internet is the key communication technology

Artists

- Creative activity is highly valued, with strong regional heritage traditions which are supported enthusiastically
- Robotic process control in industrial enterprises eliminates most routine repetitive manufacturing tasks, leaving citizens with more time to pursue creative pursuits

Trade

- Highly inter and intra-connected society
- Adoption of global connectivity and mutual recognition/exchange of technical and cultural information
- Electronic commercial networking with the world community
- Technical and cultural produce of the regions are highly regarded and sought by the external world

Economic Structure

- Agriculturally self-sufficient

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- Small-scale industrial enterprises: convergent technologies render scale economies irrelevant
- Leisure/services sector is very dynamic

Research infrastructure

- Emphasis on harnessing and adapting technologies, rather than investment in original research; although some is done to enable knowledgeable acquisition.
- Regional research bodies seek to acquire and adapt appropriate new technologies for their inhabitants, taking into account the specific needs of different population groups, which may vary from region to region.

A research co-ordinating body ensures full exchange of information and activities across regions, and can be tasked to take a lead on any appropriate pan-European issues.

How to identify future trends

- Emphasis on harnessing and adapting technologies puts a premium on technology foresight, facilitated by global inter-connectivity
- Regional research bodies are the prime drivers of foresight activities
- Citizens, entrepreneurs and institutions are very receptive to new ideas and innovations and there is a fluency of debate and discussion within the society as to future trends

Effect of Wild Cards

- *Global Warming*
 - Will produce local stresses which adaptive technology ameliorates. The challenge of sea level rise is met by technology!
- *Black Hole / Asteroid*
 - No action; no point
- *Hostilities, wars and conflicts.*
 - We have EDO; which will sort out regional differences
- *Economic Instability*
 - Inherently; not as bad as elsewhere, as we are more self contained. We have realised the futility of the consumer-based society with its emphasis on 'growth' which in 2020 is accepted as unsustainable. European society has moderated its needs; and all goods come with a tag to indicate its 'sustainability quotient'.
- *War in China*
 - Seen as an opportunity to enter new markets previously closed! Some immigration would be welcomed to bolster the ageing population.
- *Social Crises?*

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- Electronic infrastructure collapses or cross interference causes breakdown? After initial dismay, our economy would be robust enough to deal with this.
- Downturn in demographics filled by vocation immigrants; or robots.

Early indicators

- Failure to agree new EU constitution
- Structural funds devolved directly to regions

Timeline

- As Europe develops an increasingly “regional” character – albeit within a European framework – the administrative and cultural frameworks of Regional Calm begin to evolve, following the breakdown of the grandiose EU super-state concept.
- Convergent technologies facilitate the evolution of the mutually inter-dependant regional model

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5. Comparison of the scenarios & implications

5.1 Scenario narrative

The four scenarios⁴ compare Europe in 2020.

Common to all scenarios are a set of assumptions (given in section 2) which suggest a volatile world, in which India and China are major scientific, technological and economic powers. Oil, gas and water are beginning to be constraints. “Old Europe” is with difficulty assimilating large numbers of immigrants, and English is widely used as a common language. Tax burdens are causing changes in attitudes to social support by the state.

Europe’s democracy will be implemented at EU, national and regional levels, with information and e-voting used by governments and NGOs. Populations everywhere will be more difficult to govern.

In terms of NBIC related developments, the science is global and will be available. The capability to work at a molecular level on materials and biological systems will give potential applications. For instance

- Capability to tailor materials, medicines, viruses and bacteria for personal, environmental or other wants.
- Computer-based and/or bio-based invasive monitoring will be possible.
- Technology will support new energy sources
- Artificial intelligence will be supporting many systems
- Sensor networks will be widespread.

The scenarios set contexts for the decisions Europe will make over the period to 2020 in exploiting these capabilities. Overall the assumption is made that society in 2020 will not have been radically changed as yet by NBIC technologies, but that decisions made between now and then will affect the future significantly.

Competitive Europe is a scenario for economic growth in Europe, in all its diversity – in fact part of the growth comes from exporting products in non-English languages and attuned to non “anglo” cultures. It depends on harnessing a positive attitude to science and technology, suggesting a focus on the accession countries, where this is more likely to be true, as leverage and investment points.

It focuses on creating new industries and applying NBIC to traditional industries with an emphasis on export, using health as an example. It requires closer university/industry collaboration, as well as major funding of basic research and a

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focus on excellence and critical mass. It emphasises fast response on funding of basic as well as applied research.

The heroes of *Competitive Europe* are Schumpeter (the entrepreneur as hero) and Hayek (free markets are the only way). The drive is for a competitive Europe, by focusing on areas where the US does not have a lead.

Alternative Lifestyles is a world with a focus on social cohesion in a Europe still diverse and growing more so. Public attitudes to science and technology are negative through to about 2010–5, and companies make moves to become “good citizens” to support social aims.

Governance is mostly in regional hands, as is economic policy. The EC focuses on research appropriate to industries facing deep structural change – energy, health, education, art, agriculture, property & trade, and money and capital management. The research infrastructure is jointly managed by regions and the EC. New regulation is needed for Internet trading.

In *Alternative Lifestyles*, times are tougher than in *Regional Calm*, because this scenario foresees structural changes forced on society across Europe by existing technology. The community-based social glue is strained by these changes.

Global Capitalism focuses like *Competitive Europe* on economic growth, uses English widely and there is pressure to conform to a homogenized model. The public are positive towards “progress” and science, and society has winners and losers.

Policy is led by the centre and focuses on export-led growth of know-how in capabilities, innovation and specialised products, while at home the main emphasis is on entertainment and leisure. The scenario is based on common technology standards, patents and regulatory regimes across Europe and sees a European Research Council. Health care emerges as a priority. Academic/industry collaboration and private/public partnerships are central to achieving the scenario.

In *Global Capitalism*, regulation will enforce common European technical and commercial standards and be oriented towards seizing economic opportunity.

Regional Calm is a world of social cohesion, positive attitudes to science and to the advantages of diversity, following the failure of big politics. Education is taken seriously. Regions provide the main forms of governance and Europe’s centralised role is limited to defence and maintaining self-regulating systems.

With no focus on economic growth, there is some impetus for new science if it is towards achieving inclusivity. The main emphasis is on using existing science and technology to achieve social aims e.g. healthy (preventive) lifestyles and quick

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deaths. The scenario assumes that Europe's localities can determine their future, and that the impatient young leave, the wealthy retirees stay.

Clearly, *Competitive Europe* and *Global Capitalism* share an economic imperative, and differ in ways of perceiving the world and hence ways of achieving this.

Alternative Lifestyles and *Regional Calm* are driven by a social agenda, but *Alternative Lifestyles* puts this in the context of severe disruption over the next decades; *Regional Calm* concentrates on what "success" would feel like.

5.2 Implications for Science & Technology topics

Competitive Europe would use science and technology to modify old industries and create new ones, focusing on export opportunities. Examples are

- topics related to sustainability, e.g. fuel cells, potable water, pollution monitoring
- health needs to develop export markets world-wide
- products for French & Spanish speaking cultures
- niche products for different climates

Alternative Lifestyles would focus on seven industries – energy, health, education, art, agriculture, property & trade, and money and capital management –facing structural change, with the aim of supporting research topics which could take them to a new economic model. Examples are:

- technology to support decentralisation
- energy smart solutions, e.g. bio-engineering to produce hydrogen
- programs to solve the greenhouse effect e.g. bio-engineering of plants to accelerate carbon dioxide take-up
- telemedicine
- artificial intelligence in support of education & the creation of know-how
- monitoring of the eco-system

Global Capitalism would concentrate on export opportunities of capability, innovation and specialist products. Examples are:

- topics related to preventive health care – . predictive medicine, understanding human genome in terms of early diagnostics, epidemiology/public health, ecology, life style regulation technologies, IT technologies for analyzing huge data sets to aid the sciences
- brain enhancements that enhance information storage & retrieval
- Basic science still needs to understand relation between genes and diseases, which may lead to medical technologies; but also it requires technological support, namely nano-technological analytic methods.

Regional Calm sees the topics as those promoting inclusivity:

- cognitive issues

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- bio-ICT issues
- Investment in harnessing new bio-/geno-technologies to extend significantly lifespan as well as quality of life. Emphasis on prevention rather than cure – reduces need for expensive “reactive” therapies
- robotics & artificial intelligence.
- topics related to sustainability, e.g. fuel cells, potable water, pollution monitoring

The topics which appear in all the scenarios are those related to health – preventive medicine, telemedicine, tailored pharmaceuticals, bio and ICT monitoring, etc. A focus on health & ageing would appear to be robust across all scenarios for an NBIC programme.

Sustainability (e.g. bio-engineering to produce hydrogen, programmes to solve the greenhouse effect, fuel cells, potable water, pollution monitoring) could be a robust focus if allied to export markets and export of capability, and used to drive economic growth.

The use of ICT is embedded in all the scenarios, as are assumptions about enhanced ICT capability and the knowledge economy – although this is not spelled out.

Cognitive issues and brain enhancement are not seen as research topics in the scenario where the public is negative about science and technology (*Alternative Lifestyles*).

5.3 Implications for Research Infrastructure

Competitive Europe

- Long term funding for basic research
- Need to support speed, flexibility, maintain good foresight
- Facilitate fast track
- Subsidiarity model & better use of existing instruments e.g. Framework Programme, Articles 168, 169 in EU treaty.
- More transparency & democracy in the process of funding, well defined criteria
- Concentration to get critical mass, centralising activities at European level, may be small units but centres of excellence
- Encouragement of entrepreneurs/spin-offs & better University/industry co-operation

Alternative Lifestyles

Possibly following the US model, with Federal funding located in a region following support arrangements and matching funding etc agreed with regional government and industry.

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Global Capitalism

- European Research Council major source for discretionary research funding
- public/private partnerships will be a priority,
- universities expected to deliver technology transfer, spin-offs, etc.;
- universities operate increasingly like enterprises – university sells its services to the industry, including profit-sharing; academic research on contracts rather than tenure;
- research funding by industry increases in absolute but not proportionate terms (but the proportion of industry-funded research doesn't)
- academic research has closer links with industrial sector (European patent act is adopted across Europe)

Regional Calm

- Emphasis on harnessing and adapting technologies, rather than investment in original research; although some is done to enable knowledgeable acquisition.
- Regional research bodies seek to acquire and adapt appropriate new technologies for their inhabitants, taking into account the specific needs of different population groups, which may vary from region to region.
- A research co-ordinating body ensures full exchange of information and activities across regions, and can be tasked to take a lead on any appropriate pan-European issues.

Common to all scenarios are links between universities, research, and industry. It is reasonable to look to a regional structure to implement this co-operation in all the scenarios.

The scenarios that are based on economic growth (***Competitive Europe, Global Capitalism***) have also a strong emphasis on basic research excellence.

5.4 Discussion points for the Core Group at the April Meeting

How do the four “Europes” differ on key parameters e.g.

- Relation between long term political will and short term consumer demand?
- Relation between EC and regional governments?
- Ability to handle aging populations including economic/tax implications?
- What areas/questions are likely to drive research?
- Regulatory framework required?
- Which is most attractive for the development of NBIC technologies?
- What are the early indicators and decision points where scenarios suggest different approaches?

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Should the group “adopt” one of the scenarios for further work as a visionary scenario? A working model of the future? Or look for recommendations that are viable (robust) across all four?

Have we learnt anything from this exercise e.g. seen new possibilities or linkages?

5.5 Conclusions

The group adopted the ***Competitive Europe*** scenario as the basis for the work of the SIG's and the Final Report, while noting that all four scenarios⁵ were very possible and key divergences should be noted.

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